LOAD MANAGEMENT IN HT INDUSTRIES BY TIME SHIFTING OF CERTAIN LOADS

July 1991

Submitted to:
Power Finance Corporation
(A Govt. of India Undertaking)

Submitted by:
Tata Energy Research Institute
New Delhi

I. INTRODUCTION.. 1

1.1 Rationale.. 1
1.2 Objective.. 2
1.3 Scope.. 3
1.4 Report Layout 4

II. POWER DEMAND/SUPPLY SITUATION.. 6

2.1 Introduction.. 6
2.2 Maharashtra.. 6
2.3 Haryana.. 8
2.4 West Bengal.. 10

III. SAMPLE SELECTION.. 19

3.1 Introduction.. 19
3.2 Maharashtra.. 19
3.3 Haryana.. 22
3.4 West Bengal.. 24

IV. MAHARASHTRA -- ASSESSMENT OF LOAD MANAGEMENT POSSIBILITIES IN HT INDUSTRIES.. 31

4.1 Introduction.. 31
4.2 Load Curve.. 31
4.3 Prelimenary Assessment of Load Management Possibilities in HT Industries.. 33
4.4 Detailed Assessment of Load Management Possibilities.. 36
4.5 Overview.. 43

V. HARYANA -- ASSESSMENT OF LOAD MANAGEMENT POSSIBILITIES IN HT INDUSTRIES.. 58

5.1 Introduction.. 58
5.2 Load Curve.. 58
5.3 Assessment of Load Management Possibilities...... 60
5.4 HSEBs Views on Load Management.. 65

VI. WEST BENGAL -- ASSESSMENT OF LOAD MANAGEMENT POSSIBILITIES IN HT INDUSTRIES.. 69

6.1 Introduction.. 69
6.2 Load Curve.. 69
6.3 Assessment of Load Management Possibilities...... 71

VII. A SCHEME TO ENCOURAGE LOAD SHIFTS.. 80

7.1 Introduction.. 80
7.2 Basic Issues in TOU Pricing.. 80
7.3 Costs of TOU Metering.. 83
7.4 TOU Tariff Schemes.. 85

VIII. CONCLUSIONS.. 93

Study Team

Kapil Thukral	Project Coordinator
G. Chandrasekar	Research Associate
Debapriya Das	Research Associate
Rajeev Aggarwal	Secretary

Acknowledgements

The study team would like to acknowledge the contributions of M/s Tandon Management Consultants Pvt. (Ltd.), M/s Triune Projects Pvt. (Ltd.) and M/s Miraj Consultants for their work in surveying HT industrial units in Maharashtra, Haryana and West Bengal respectively. Thanks are due also to Mr. M.P. Gulati of the PFC, and various officials of the SEBs of Maharashtra, Haryana and West Bengal as well as of the Faridabad Industries Association for their help and guidance from time to time.

ANNEXURES

IV.1 Maharashtra -- Sample of HT Industrial Establishments.. 95
V.1 Haryana -- Sample of HT Industrial Establishments...... 96
VI.1 West Bengal -- Sample of HT Industrial Establishments.. 97
VII.1 Explanation of Metering Circuit........................ 98

TABLES

1.1 India -- Role of HT Industrial Establishments in Utility Power Sales.............................. 5

2.1 MSEB -- Share of Sales to HT Industries.............. 12
2.2 MSEB -- Number of Consumers and Connected Load....... 12
2.3 HSEB -- Maximum Demand and Time-of-Day it Occurs..... 13
2.4 HSEB -- Share of Sales to HT Industries.............. 14
2.5 HSEB -- Number of Consumers and Connected Load....... 14
2.6 WBSEB -- Maximum Demand and Time-of-Day it Occurs.... 15
2.7 WBSEB -- Share of Sales to HT Industries............. 16
2.8 WBSEB -- Number of Consumers and Connected Load...... 16

3.1 Maharashtra -- HT Consumer Data (as of July 1988).... 26
3.2a Maharashtra -- Population and Sample Size of HT Consumers.. 27
3.2b Maharashtra -- Population and Sample Size of HT Consumers.. 28
3.3 HSEB -- Population of HT Industries in Faridabad with Connected Load Exceeding 500 kW................ 29
3.4 HSEB -- Sample Size of HT Industrial Establishments in Faridabad.. 29
3.5 WBSEB -- Number of HT Industrial Consumers in Selected Areas and Sample Size...................... 30

4.1 Maharashtra -- Summary of HT Establishments According to Industry Type 44
4.2 Maharashtra -- Share of Electricity Use by Selected HT Industries During Times of System Peak (%)........ 49
4.3 Maharashtra -- Possibility of Load Shifts and Energy Conservation in Selected HT Industries.............. 50
4.4 Maharashtra -- Extent of Time Shifting of Loads Possible in Selected Industries..................... 51
4.5 Maharashtra -- Incentives Required for Time Shifting of Loads.. 53
4.6 Maharashtra -- Problems Anticipated in Shifting Loads from Peak to Off-peak Periods...................... 54
4.7 Maharashtra -- Scope for Overall Electricity Conservation.. 55

5.1 Haryana -- Share of Power Consumption in Morning and Evening Peak Hours............................. 67

6.1 West Bengal -- Share of Electricity Use by Selected HT Industries during Times of System Peak............ 75
6.2 West Bengal -- Extent of Load Shifting Possible in Selected Industries................................. 76
6.3 West Bengal -- Power Supply Restriction on Selected Industries... 77
6.4 West Bengal -- Number of Workers in Selected Industries... 78

7.1 Baseline Costs of Power Generation Using DG sets..... 88
7.2 Cost per kWH of Power Generation Using DG sets....... 89
7.3 Cost Estimate per HT Consumer for Implementing an Experimental TOU Metering Scheme.................... 90
7.4 Suggested TOU Tariff Rates in Maharashtra, Haryana and West Bengal (paise/kWh).......................... 91

FIGURES

2.1a Frequency distribution of morning peak occurrences for MSEB.. 17
2.1b Frequency distribution of evening peak occurrences for MSEB.. 17
2.2a Frequency distribution of morning peak occurrences for HSEB.. 18
2.2b Frequency distribution of evening peak occurrences for HSEB.. 18

4.1 MSEB -- Average Load Curve for HT Industries.......... 57

5.1 HSEB -- Overall Load Curve for HT Industries.......... 68
5.2 HSEB -- Average Load Curve for Light Engineering Industries... 68
5.3 HSEB -- Average Load Curve for Heavy Engineering Industries... 68
5.4 HSEB -- Average Load Curve for Process Industries..... 68

6.1 WBSEB -- Average Load Curve for HT Industries......... 79

7.1 Design of an Experimental Scheme for TOU Metering..... 92

I. INTRODUCTION

1.1 Rationale

Electric power utilities in India have relatively few large high-tension (HT) consumers, which account for a disproportionately large share of total energy sales. Table 1.1 shows that in 1986/87 -- the most recent period for which data are available -- less than 22,000 HT consumers (i.e, 0.04% of the total number of consumers) in the country accounted for about 39% of total utility sales. In other years also, the same general pattern is evident.

Owing to lack of reliable and sufficiently disaggregated information, it is not possible to estimate with any degree of precision, the contribution of HT industrial consumers to utility system peak loads. However, it may be noted that in most utilities, these HT consumers are often subject to the most severe power supply restrictions -- and particularly during times of system peak loads.

Power supply restrictions do help to smoothen the load curve of the utility system to a significant extent, but are a form of load management that probably encourage HT consumers to resort to standby/captive source of power generation*. Therefore, this leads to an anomalous situation, where the consumer load curve represented in the utility system load curve is very different from the actual power consumption pattern of the consumer.

---

* Most HT industrial establishments now have some standby/back-up source of power generation. This is not formally planned for by the organized power supply industry in the country, but is a consequence of independent decisions taken by entrepreneurs, in view of expectations of continued power shortages. This leads to a situation of over-capitalization of the power supply capacity. Besides, it is also a drain on scarce foreign exchange resources as it is largely high-speed-diesel (HSD) based.

Instead, it would be useful if other load management techniques could be resorted to, in which the user shifts part of the loads from times of system peak to off-peak hours -- and in a manner so that the common practice of taking recourse to standby/captive generation is minimized.*

It would be useful to concentrate, on HT industries for affecting load management for two reasons : (i) it enables one to focus attention on relatively few consumers -- any success in any one HT consumer will have a relatively large impact on the overall system performance; and (ii) it enables one to deploy relatively more expensive equipment for implementing load management measures.

1.2 Objective

Against this background, it becomes relevant to study the load management possibilities in HT industries in India. For the purposes of the present study, HT industrial consumers in th following three states are considered :

(i) Maharashtra in the Western Region;
(ii) Haryana in the Northern Region; and
(iii) West Bengal in the Eastern Region.

Although particular emphasis is given to time shifting of loads in order to smoothen the load curve, other general measures regarding energy conservation (which would also lead to a reduction in the industrial load at system peak time -- and hence to an overall reduction in the system peak load) are also considered.

---

[*] Some of the other more common load management techniques practise in India are staggering of holidays, staggering of lunch-hou breaks etc.

1.3 Scope

The ideal approach for this study would be to obtain the load profile for each HT industrial unit that draws power from the concerned state electricity Board (SEB). All the load profiles thus obtained for particular industry categories could then be added up to obtain overall representative load profiles. Further aggregation would lead to an estimate of the load curve of all HT industrial consumers at the state level. In fact, this procedure would permit the identification of particular industrial categories that influence the overall HT industrial load curves at times of system peak -- and thus enable one to establish priorities towards the implementation of load management measures.

Having thus identified the types of industries for affecting load management, the next step would be to carry out in-depth studies of industrial units and manufacturing steps with a view towards : (i) identification of constraints (if any) and an analysis of economic implications for shifting major electrical loads to off-peak periods; and (ii) formulation of an incentive based scheme to encourage industrial establishments to relocate loads, change shift timings etc.

Such a detailed assessment however, would be very time consuming, and is beyond the scope of the present study. Instead of trying to obtain the daily load profile of all HT industrial units in the concerned states, the attempt is towards first identifying a suitable representative sample of HT industrial establishments, and then collecting their load profiles and studying manufacturing processes further.

The method of sample selection is different in each state, and is adapted to the data availability situation (regarding type of industry, connected load, contract demand etc.) in each SEB. Although it is generally known that the potential for time-shifting of loads is relatively low in industrial units that are predominantly of the continuous process type, and tends to be relatively high in batch process type industries, both types are selected in the sample, so as to enable a better estimation of load management possibilities at the state level.

Further, a suitable menu of time-of-use (TOU) tariffs is also devised. TOU metering aspects are also addresed.

1.4 Report Layout

Chapter II gives the power situation in the states of Maharashtra, Haryana and West Bengal, and details the reasons for implementing load management strategies. The sample selection process is discussed in Chapter III. The findings of the field survey of industrial consumers are given in Chapters IV, V and VI for Maharashtra, Haryana and West Bengal respectively. Chapter VII gives the design of a TOU tariff implementation scheme as well as an indicative tariff menu for the three states. Finally, the basic conclusions of the study are summarized in Chapter VIII.

Table 1.1 India -- Role of HT Industrial Establishments in Utility Power Sales

	No. of Consumers ('000)		Energy Sales (Gwh)	
	Total	HT	Total	To HT Consumers
1980/81	32,571.3	23.5	82,367	40,654
1984/85	44,636.0	20.2	114,068	51,791
1986/87	52,317.2	21.9	135,952	52,618
1988/89	--	--	159,719	59,283

Source : Central Electricity Authority (CEA), Public Electricity Supply : All India Statistics -- General Review, New Delhi, various issues.

II. POWER DEMAND/SUPPLY SITUATION

2.1 Introduction

Load shifting is an important form of load management. The relevance of pursuing and implementing load management schemes is discussed below.

Although appropriate load management strategies may be implemented on any category of consumers; to begin with, it may be meaningful to focus efforts on large high-tension (HT) consumers. This is so, because a relatively small number of consumers (less than 1%), account for a substantial share of the sales (about 40%), and any success in implementing load management measures will have a significant impact on the load curve of the entire system.

2.2 Maharashtra

The Western Regional Electricity Board (WREB) is an association of various SEBs and other power utilities of the Western Region. The Maharashtra State Electricity Board (MSEB) is one of the constituents of the WREB, and has power exchange arrangements with Gujarat Electricity Board (GEB) and Madhya Pradesh Electricity Board (MPEB), and also exports power to Goa Electricity Department (GED). MSEB also obtains power from central sector agencies (as per its allocated share) like National Thermal Power Corporation (NTPC) and Nuclear Power Corporation (NPC).

Data given in Tables 2.1 and 2.2 show that during the 1980s, the HT industrial consumers, who were only 0.07% of the total number of consumers in Maharashtra, accounted for 43% to 49% of MSEBs electricity sales, while their share of the connected load declined gradually from 30% in March 1982 to 24% in March 1987.

Furthermore, according to the Thirteenth Electric Power Survey of India (1989)*, the power supply situation is going to be characterized by shortages during the early and mid-1990s. Energy deficit of 4.7% of the requirement, and peak power availability deficit of 13.1% of the peak load requirement, are projected for 1994/95 for the state of Maharashtra. An overall peak power deficit is projected for the entire Western Region also -- although there may be a small amount of surplus power at off-peak times. In fact, these deficit projections may be underestimated -- for the implicit assumptions, in terms of additions to generating capacity in the Eighth Five Year Planning (FYP) period (1990/91 - 1994/95) may not be realized=. It therefore becomes relevant and necessary to consider ways and means of implementing load management measures in each constituent system of WREB -- including the MSEB.

The basic issue therefore is to see how and when the peak load requirements can be reduced. For this purpose, the MSEB system load curve needs to be studied.

TERI obtained hourly data on MW despatches (for consumption within the state of Maharashtra), from the MSEB load despatch centre for the period July 1989 to February 1990. These data are analyzed with respect to time of occurrence of the system peak both in the morning and evening. The results are presented in figure 2.1, and clearly show that the morning system peak normally occurs between 9 AM and 11 AM, and the evening peak between 7 PM and 9 PM. Moreover, before and after these clock times, the system demand often falls rather significantly.

---

* Central Electricity Authority, "Thirteenth Electric Power Survey of India", New Delhi, 1987.

= As per the Thirteenth Electric Power Survey (1987), a total of about 38,370 MW of generating capacity was to be added during the Eighth FYP period. However, as per present expectations, at most 28,000 MW may actually be added.

For analytical purposes therefore, it may be assumed that the system peak for MSEB occurs from 9 AM to 11 AM in the morning, and from 7 PM to 9 PM in the evening. The purpose of the present study would be to understand how loads in HT industries during these times can be reduced.

2.3 **Haryana**

The Haryana State Electricity Board (HSEB) is primarily responsible for generation and supply of power in Haryana. It is one of the constituents of the Northern Regional Electricity Board (NREB), and has power inter-change arrangements with several neighbouring utilities. The HSEB purchases/imports power from the Bhakra-Beas Management Board (BBMB) and central sector agencies like NTPC. One of the HSEB owned thermal power units (62.5 MW) is located in Delhi, at the IP Power Station. Despite this, the Haryana power supply situation has been characterized by heavy shortages during the past decade. For instance, the estimated energy deficits in 1985/86 were 23.3% of the requirement. And according to the Thirteenth Electric Power Survey (1987), the projected energy deficit in 1994/95 is 6.8% of the energy requirement, and the peak availability deficit 28.5% of the projected (unrestricted) peak load. An overall peak power deficit is projected for the entire Northern Region as well, by about 3750 MW or 16.3% of the projected peak load in 1994/95. As explained in section 2.2 in the context of Maharashtra, these estimated deficit projections may in fact be underestimated.

Another way of gauging that there are significant power shortages is that the load factor is rather high (about 85% in 1988/89). The high load factor is a reflection of power supply restrictions (including brown-outs, low voltage and low frequency conditions) rather than of implementing genuine load management measures whereby which consumers adjust their electricity consumption patterns to smoothen their load curves.

In fact, the HSEB is often obliged to export power to neighbouring utilities, even when its own requirements are not fully met. As a result, the system peak of the HSEB system in Haryana occurs at any time of the day. Table 2.3 lists the maximum demand recorded in Haryana month-wise during 1988/89 and 1989/90, and also the time-of-day when this monthly peak occurred. Surprisingly, the peak occurred even during the 11 PM to 5 AM period. This is more a reflection of the power availability situation rather than of the intrinsic demand patterns of the electricity consumers in Haryana. Similarly, figure 2.2 shows that morning peaks recorded during July 1989 through February 1990 occurred any time between 1 AM and 12 noon, and evening peaks any time between 1 PM and 12 midnight.

Against this background, it becomes relevant and meaningful to explore options for load management. Tables 2.4 and 2.5 show that in 1980/81, less than 0.06% consumers (which were HT industries) accounted for nearly 35% of total energy sales to final consumers.

In 1986/87, the HT consumers (who were less than 0.05% of the total number) accounted for nearly 23% of HSEB sales to consumers within the state. It is clear therefore, that it would be useful, for a beginning, to focus attention on pursuing and implementing load management measures in HT industries.

As the HSEB operates as a part of the Northern Region grid, and the morning and evening times of the Northern Region are 6 AM to 10 AM and 6 PM to 10 PM respectively, it is clear that one of the objectives of the load management programmes in Haryana should be to ensure that the electricity requirements of the HT consumers do reduce during these times. This is doubly relevant for the evening peak hours, when the normal practice is to use standby generators -- usually diesel generator sets, which run on high speed diesel (HSD). It needs no reiteration here that HSD is a fuel that is imported at the margin, and its use for standby power generation leads to the expenditure of India's scarce foreign exchange resources.

2.4 **West Bengal**

The West Bengal State Electricity Board (WBSEB) is responsible for power supplies in the state of West Bengal. It is one of the constitutents of the Eastern Regional Electricity Board (EREB). The WBSEB imports/purchases power (as per its allocated share) from the Damodar Valley Corporation (DVC) and Central Sector agencies like NTPC. It also has power interchange arrangements with the power utilities in the neighbouring states of Bihar and Orissa.

The power supply situation in West Bengal is characterized by shortages. Power supply restrictions are imposed on HT industrial consumers, particularly during evening peak times. According to information available, the evening peak usually occurs between 5 PM and 8 PM.* Table 2.6 gives the exact time during which the maximum demand occurred each month during the years 1988/89 and 1989/90. The morning peak is reported to occur normally between 8 AM and 11 AM. For analytical purposes therefore, it is assumed that the times of morning and evening system peak are as stated above.

According to the Thirteenth Electric Power Survey (1987), a peak power availability deficit of 916 MW (9% of the peaking requirment of 10177 MW) is projected for the entire Eastern Region -- although a surplus energy availability is forecast for the Region.# This probably suggests the imperative need to promote load management measures in all types of consumers in the state.

As is evident from Tables 2.7 and 2.8, the HT industrial consumers account for over 50% of the sales of power even though they are less than 1% of the total number of consumers in the state -- a fact which reiterates the importance of focussing initial efforts towards load managment on HT industries.

---

* It tends to be between 5 PM and 6 PM in the winter months; and 7 P to 8 PM during the summer months.

# However, as explained in the context of Maharashtra, the energy surplus situation may not occur and the peak deficits may b underestimated.

Table 2.1: MSEB -- Share of Sales to HT Industries

	1980/81	1984/85	1986/87	1988/89
Total Sales (GWh)	14037.41	19059.25	19974.89	25258.95
- HT Industry (GWh)	6892.23	8472.67	9836.69	10962.73
- HT Industry (%)	49.1	44.5	49.2	43.4

Table 2.2 : MSEB -- Number of Consumers and Connected Load

	As on 31st March		
	1982	1985	1987
Number of consumers			
- total	5094,937	6856,424	8060,420
- HT industry	3,581	4,772	5,164
Connected Load (MW)			
- total	10,455.7	13,747.1	15,462.2
- HT industry	3027.8	3770.1	3724.7

Table 2.3 : HSEB -- Maximum Demand and Time-of-Day it Occurs

Month	Max. Demand (mW)	Time of Max. Demand
Apr, 1988	1046	7 PM
May, 1988	1167	2 AM
Jun, 1988	1021	8 AM
Jul, 1988	989	5 AM
Aug, 1988	1148	11 PM
Sep, 1988	1227	11 PM
Oct, 1988	1000	9 PM
Nov, 1988	1122	8 AM
Dec, 1988	1228	9 AM
Jan, 1989	1164	9 PM
Feb, 1989	1212	7 AM
Mar, 1989	1194	9 AM
Apr, 1989	1149	11 PM
May, 1989	1141	9 AM
Jun, 1989	1117	9 AM
Jul, 1989	1208	12 midnight
Aug, 1989	1307	10 AM
Sep, 1989	1445	8 PM
Oct, 1989	1419	11 PM
Nov, 1989	1258	6 AM
Dec, 1989	1268	10 AM
Jan, 1990	1328	5 AM
Feb, 1990	1219	1 AM
Mar, 1990	1218	7 AM

Table 2.4 : HSEB -- Share of Sales to HT Industries

	1980/81	1984/85	1986/87	1988/89	1989/90
Total Sales (GWh)	2555.89	3115.70	3848.65	4708.66	5835.00
HT Industry (GWh)	891.21	755.36	957.42	1076.51	NA
HT Industry (%)	34.86	24.24	24.87	22.86	NA

Table 2.5 : HSEB -- Number of Consumers and Connected Load

	As on 31st March			
	1982	1985	1987	1990
Number of Consumers				
- total	1219,173	1624,936	1864,644	2346,890
- HT industry	707	847	907	1000
Connected Load (MW)				
- total	2357.74	3034.02	3398.51	4267.00
- HT industry	416.60	541.03	584.70	603.78

Table 2.6 : WBSEB -- Maximum Demand and Time-of-Day it Occurs

Month	Maximum Demand (MW)	Time of Maximum Demand
Apr, 1988	642	7 PM
May, 1988	597	7 PM
Jun, 1988	599	8 PM
Jul, 1988	586	7 PM
Aug, 1988	609	7 PM
Sep, 1988	608	7 PM
Oct, 1988	597	6 PM
Nov, 1988	598	6 PM
Dec, 1988	564	6 PM
Jan, 1989	608	6 PM
Feb, 1989	619	7 PM
Mar, 1989	678	7 PM
Apr, 1989	673	8 PM
May, 1989	675	7 PM
Jun, 1989	604	8 PM
Jul, 1989	647	7 PM
Aug, 1989	657	8 PM
Sep, 1989	674	8 PM
Oct, 1989	677	7 PM
Nov, 1989	685	6 PM
Dec, 1989	645	6 PM
Jan, 1990	701	7 PM
Feb, 1990	686	8 PM
Mar, 1990	716	8 PM

Table 2.7 : WBSEB -- Share of Sales to HT Industries

	1980/81	1984/85	1986/87
Total Sales (GWh)	5677.84	6741.32	7668.28
- HT Industry (GWh)	3221.28	3603.52	3960.23
- HT Industry (%)	56.73	53.45	51.64

Table 2.8 : WBSEB -- Number of Consumers and Connected Load

	As on 31st March		
	1982	1985	1987
a. Number of consumers			
- total	1292,846	1513,008	1857,704
- HT	1,913	2,044	2,295
b. Connected Load (MW)			
- total	3161.6	3713.5	4063.1
- HT	1022.6	1107.3	1127.0

Fig. 2.1a Frequency distribution of morning peak occurences for MSEB

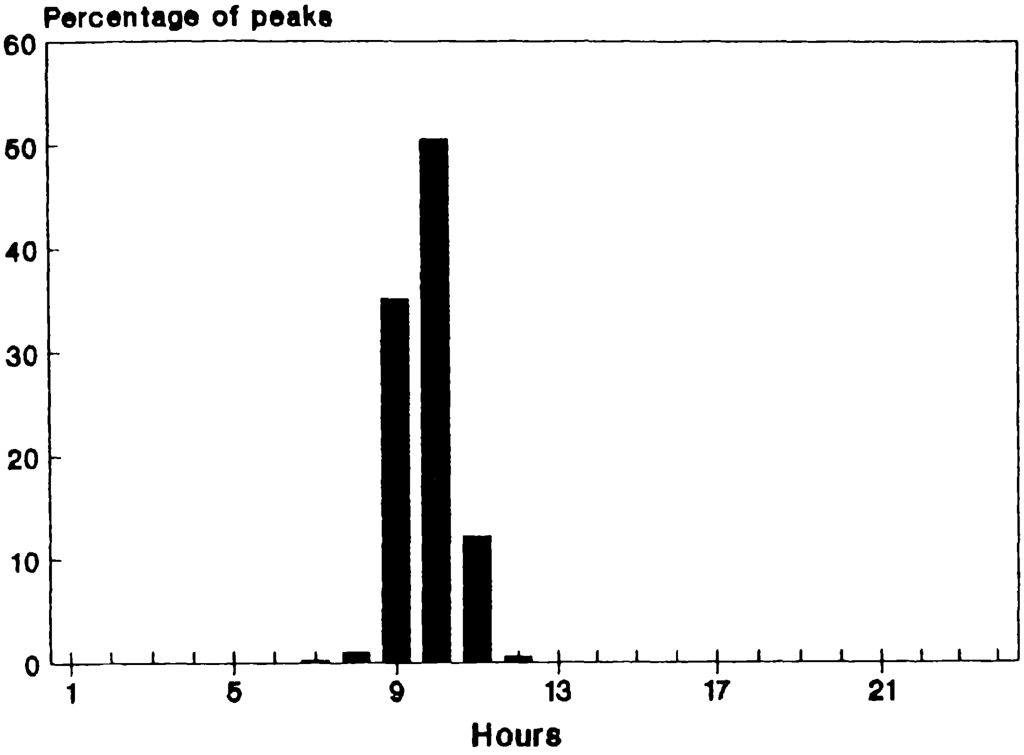


Fig. 2.1b Frequency distribution of evening peak occurences for MSEB

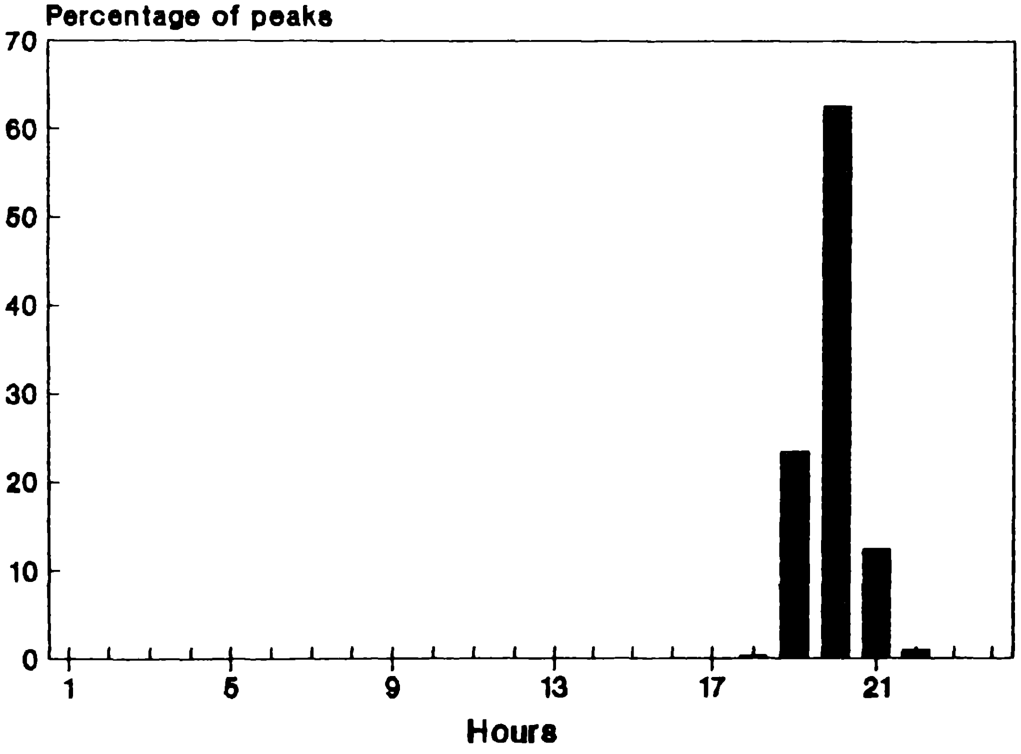


Fig. 2.2a Frequency distribution of morning peak occurences for HSEB

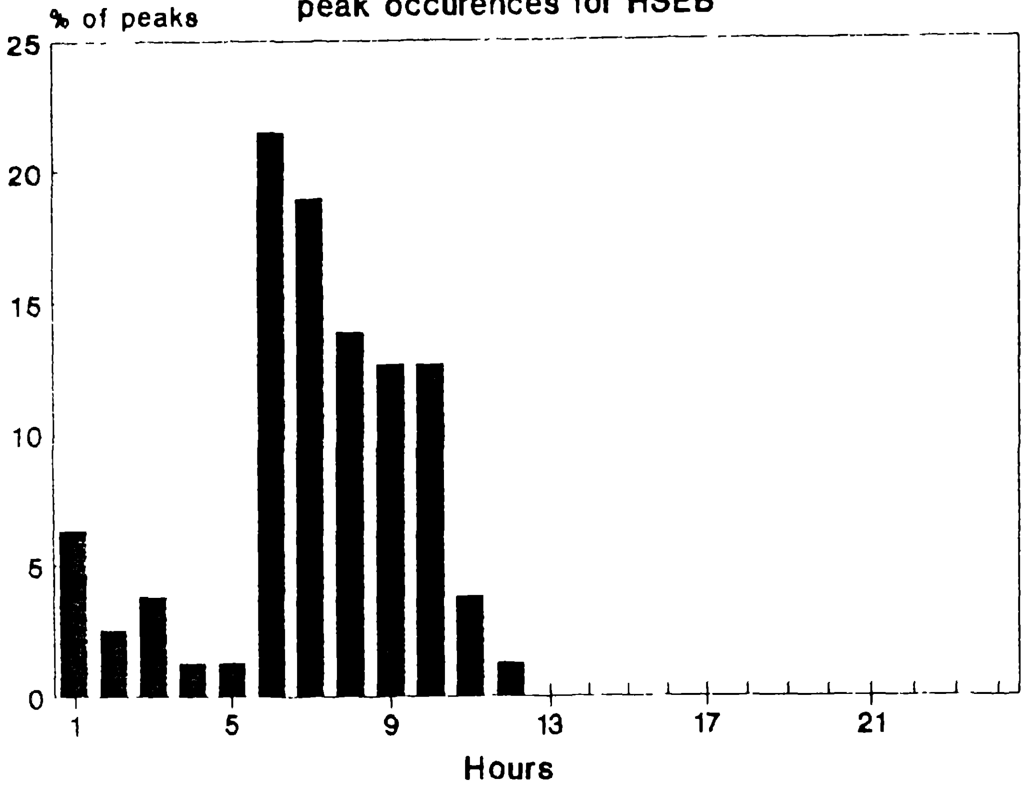
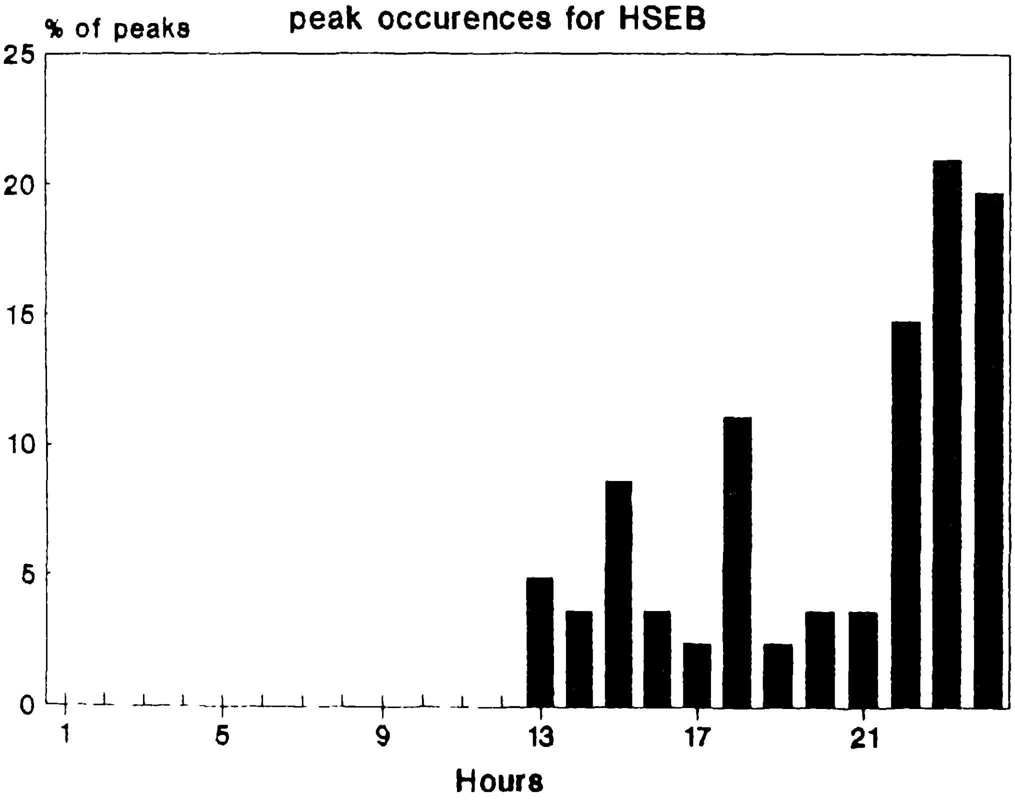


Fig. 2.2b Frequency distribution of evening peak occurences for HSEB



III. SAMPLE SELECTION

3.1 Introduction

Owing to differences in the manner in which data are maintained in the three SEBs of concern, the procedure adopted for selecting the sample is very different for each. Sections 3.2 through 3.4 explain the sample selection process in the three states, and also detail the sample.

The basic objective of the sample selection procedure is to come up with a sample of HT industries that can give a daily load profile that is representative of the entire population of HT industries in the concerned state.

3.2 Maharashtra

The Maharashtra State Electricity Board (MSEB) maintains a computerized list of all HT industrial consumers and other HT consumers in the state. This list gives the names and addresses of HT industries, as well as contract demands. TERI had access to this list, on the basis of which, a representative sample was drawn.

According to information available, MSEB serviced over 6000 HT consumers at the end of July 1988. These consumers were spread all over Maharashtra in 24 circles. Table 3.1 gives the number, total contract KVA demand and average KVA demand per HT consumer in each circle in July 1988. The number of HT consumers has increased since then. According to the most recent information available to TERI, their number increased between July 1988 and February 1989, from 842 to 891 in the Bombay (Rural) circle, from 765 to 775 in the Bombay (Urban) circle, from 297 to 305 in the Nagpur (Urban) circle, from 176 to 179 in Bhandup (Urban) circle, and so on. The number of HT consumers serviced by MSEB in February 1989 is available only for eight circles. Details giving names, locational addresses and contract demand for each HT consumer in these eight circles were obtained by TERI. These data are used to select the sample of HT consumers for the field survey.

Table 3.2 shows the number of HT consumers (by type or category) in eight circles in February 1989: Bombay (Urban), Bombay (Rural), Bhandup (Urban), Bhiwandi (Urban), Jalgaon O & M, Nagpur (Urban), Nagpur (Rural) and Chandrapur. For convenient logistics and for expediting the survey work, the actual sample for the field survey however, is selected from only two circles: Bombay (Urban) and Bhandup (Urban). Tables 3.2a and 3.2b also show the number of HT consumers (by type) from these two circles.

A stratified sampling technique is used for selecting the sample. The first strata is on the basis of the major classification of the HT consumer (chemicals, engineering, textiles, metallurgy etc.); and the second strata is on the basis of contracted demand. The total sample size is fixed at 130. The sampling technique is detailed below.

Although ideally the number of HT consumers (by type) should be as per their population in the entire state, this is not possible due to data limitations on two accounts. First, details regarding locational addresses and KVA demand by type of HT consumer are available only from eight circles -- which means that the sample, as per the number of HT consumers (by type), can be drawn from those eight circles only. Second, that nearly 65% of the total number of HT consumers in the eight circles are classified as "miscellaneous". This entire list of miscellaneous consumers can not be treated as being of one type, as an examination of the names obviously indicates that they comprise a heterogeneous lot -- banks, hotels, street lights, other commercial/institutional consumers etc., as well as various types of manufacturing industries. However, just by seeing their names on the list, the exact activity can not often be identified -- this is particularly true for manufacturing industrial establishments in the "miscellaneous" category. Discussions with MSEB officials revealed that the information on the actual activity of these HT consumers could be obtained from the concerned circle offices either by: (i) consulting the distribution staff, who would personally know the work/activity their clients engaged in (for instance, manufacture of footwear, leather items, metal products etc.): or/and (ii) seeing the letter of sanction of power connection to the concerned HT consumers, in which the "purpose" for obtaining the sanction is always stated.

This information could be obtained for most consumers in the Bombay (Urban) and Bhandup (Urban) circles, but only after scanning the records very carefully or/and discussions with the distribution staff.

For selecting the sample, the various types of categories of HT industries are clubbed into a few groups, as listed in Tables 3.2a and 3.2b (eg. chemicals, pharmaceuticals and fertilizers as one group). This is necessary, because it is not possible to draw a meaningful sample for certain types of industries whose number is very small.

The sample size for each major group of consumer is therefore selected on the following basis : (i) for non-miscellaneous consumers as given in Table 3.2a, as per the population in eight circles; and (ii) for miscellaneous consumers as given in Table 3.2b, as per the population in Bombay (Urban) and Bhandup (Urban) circles only. Within each group, the second criteria for selecting a particular consumer in the sample is its contract demand.

For each sample establishment so selected, one or two additional units belonging to the same type or category, and the same contract demand range slab were also identified -- which were to be surveyed only if the response from the selected establishment was not forthcoming.

3.3 Haryana

The situation with the Haryana State Electricity Board (HSEB) is very different. They do not have a complete listing of HT industries, and were therefore not in a position to give to TERI the required information on HT industrial consumers in different districts or circles/divisions in the state of Haryana.

Therefore, owing to the fact that Faridabad is a major industrial area in Haryana, the work is confined essentially to that district. As the HSEB head-office in Panchkula could not make available a listing of industries, it was obtained (for Faridabad only) from the following four sub-divisional offices in Faridabad : (i) City sub-division; (ii) Old Faridabad; (iii) Industrial

Area; and (iv) Ballabgarh. This information was also augmented by the Faridabad Industries Association (FIA).

TERI is aware that there are a significant number of HT industries in other parts of Haryana also (for example, Panipat district). However, as nearly 40% of the HT industrial consumers are in Faridabad alone, a reasonable sample selected from Faridabad may be considered to be representative of the entire state.

According to the information available to TERI, there are 399 HT industrial consumers in Faridabad. These include various types of industries such as stone crushing, engineering, chemicals, textiles, steel, forging, foundry etc.

Of these 399 HT industrial establishments, 125 have connected loads of more than 500 kW. For purposes of conducting the field survey, such industrial establishments are divided into three basic categories : light engineering, heavy engineering and process industries. Table 3.3 gives the number of these industries, as per two connected load range slabs (500 to 1000 kW, and over 1000 kW*.

Although it was intended to include about 40 industrial units in Faridabad, adequate cooperation was obtained only from 27, as given in Table 3.4. However, it may be noted that all the types of industries and connected load range slabs are indeed represented in the field survey.

---

* HT industries with a connected load of less than 500 kW wer considered too small to have/show any interest in implementing lo management measures. Consequently, they were excluded from th sample. Refer to J.L. Bhardwaj, "Flattening of Load Curve an Optimal Utilization of Capacities in the Power System", 1990.

It may be noted that unlike Maharashtra, a two-stage field survey is not conducted for Haryana. This is solely due to the fact that considerable time was lost in trying to obtain a list of HT industries in the state -- and then to, the list for industries in Faridabad only could be obtained.

3.4 West Bengal

The West Bengal State Electricity Board (WBSEB) also could not make available a complete listing of HT industrial consumers in the state of West Bengal. However, a partial list could be made available only for the following five areas : (i) Calcutta; (ii) Howrah; (iii) Hoogly; (iv) 24 Parganas (North); and (v) 24 Parganas (South).

According to the information available, there are 110 HT industrial establishments in these areas. Various types of industries are included in this list (agro-based, chemical, engineering, steel mills, jute, textile, paper etc.). Table 3.5 gives the number of industries of various types; as well as the number included in the sample.

As the available information also included the maximum demand (kVA) in 1989/90 for all 110 HT industrial units, the sample included industrial units of each type and all maximum demand ranges.

It may be noted that although there are about 2000 HT consumers in West Bengal, the sample is drawn only from 110. This was necessitated owing to lack of adequate information, as discussed above. Nevertheless, it is hoped that the inferences regarding load management possibilities derived from this sample, will hold true for all HT industrial consumers in the state.

Table 3.1 : Maharashtra -- HT Consumer Data (as of July 1988)

Circle	Number	Total Demand (kVA)	Demand per Consumer (kVA)
Bombay (Rural)	842	381,323	453
Bombay (Urban)	765	378,957	495
Pune (Rural)	499	107,257	215
Pune (Urban)	476	233,892	491
Kolhapur O & M	436	56,043	130
Nasik O & M	335	83,572	250
Sangli O & M	324	27,599	85
Nagpur (Urban)	297	107,699	363
Aurangabad O & M	272	83,320	306
Jalgaon O & M	190	101,361	533
Ahmednagar O & M	182	36,929	203
Bhandup (Urban)	176	131,021	744
Akola	162	19,620	121
Sholapur O & M	154	33,496	218
Nagpur (Rural)	128	102,294	800
Nanded O & M	123	14,059	114
Ratnagiri O & M	114	18,797	165
Dhule O & M	110	15,324	139
Chandrapur	99	157,373	1589
Amravati	85	6,317	74
Latur O & M	80	8,484	106
Wardha O & M	63	11,120	176
Yavatmal	59	7,653	130
Bhiwandi (Urban)	49	28,201	575

Note : The 24 circles have been arranged in the descending order of number of HT consumers.

Table 3.2a : Maharashtra -- Population and Sample Size of HT Consumer

	Group Code	In eight circles	In Bombay (U) and Bhandup(U) circles	Sample Size
Chemicals		227	96	
Pharmaceuticals		54	30	
Fertilizers		10	1	
Sub-total	A	291	127	14
Textiles		120	30	
Synthetics		39	7	
Sub-total	B	159	37	8
Engineering		207	79	
Defense		55	4	
Sub-total	C	262	83	13
I & S		161	27	
Metallurgy		34	2	
Non-Ferrous		18	9	
Sub-total	D	213	38	10
Cement		11	2	
Coal		28	1	
Paper		68	13	
Ice Factory		41	17	
Cold Storage		45	29	
Sugar		10	0	
Sub-total	E	203	62	10
Miscellaneous	F	1939	607	75
Total		**3067**	**954**	**130**

Table 3.2b : Maharashtra -- Population and Sample Size of H Consumers

	Group Code	In Bombay (U) & Bhandup (U) Circles	Sample Size
Agriculture		3	
Auditorium		1	
Bank		3	
Govt. Dept.		31	
Hospital		6	
Hotel		1	
Institutions/ Office		20	
Rail Traction		3	
Residential		5	
Street Lights		20	
Water works		22	
Sub-total	FA	115	Nil
Chemicals		80	
Fertilizers		1	
Pharmaceuticals		3	
Sub-total	FB	84	13
Engineering	FC	172	27
Cement		2	
Cold Storage		12	
Electronics		6	
Electrical		7	
Floormill		6	
Food		27	
Footwear		2	
Ice		4	
Leather		2	
Miscellaneous		93	
Metallurgy		11	
Non-ferrous		1	
Edible-oils		4	
Paper		1	
Rubber		11	
Steel		9	
Stone		7	
Synthetics		7	
Textile		24	
Sub-total	FD	236	35
Total		**607**	**75**

Table 3.3 : HSEB -- Population of HT Industries in Faridabad with Connected Load Exceeding 500 kW

	Connected Load Range (kW)	
	500 to 1000	>=1000
Light Engineering	31	38
Heavy Engineering	17	10
Process	14	15

Table 3.4 : HSEB -- Sample Size of HT Industrial Establishments in Faridabad

	Connnected Load Range (kW)	
	500 to 1000	>=1000
Light Engineering	12	6
Heavy Engineering	1	3
Process	4	1

Table 3.5 : WBSEB -- Number of HT Industrial Consumers in Selected Areas and Sample Size

	No. of HT Industrial Consumers	Sample Size
Agro-industry	3	2
Chemical/Pharmaceutical	16	9
Engineering	25	12
Steel/Metals	22	14
Textiles/Jute	18	5
Others*	26	10
Total	**110**	**52**

* Includes electronics, glass, paper etc. industries.

IV. MAHARASHTRA -- ASSESSMENT OF LOAD MANAGEMENT POSSIBILITIES IN HT INDUSTRIES

4.1 Introduction

The survey of HT industries served by the MSEB, was conducted in two stages. In the first stage, the 130 industries selected in the sample (Table 3.2a and 3.2b) were surveyed, with the twin objectives of : (i) estimating the overall load profile of HT industries; and (ii) identifying candidate industrial establishments which display some potential for load management. In the second stage, the survey focused essentially on the latter group of industrial units, with the objectives of quantifying, to the extent possible, the extent to which load management could be achieved, the costs that might be incurred, and the incentives for doing so.

The findings of both the stages of the field survey are presented below.

4.2 Load Curve

Hourly meter readings were taken on two consecutive working days in order to get an idea of the hourly load profile. It is of course realized that it would be better if the power consumption profile could be observed for a few days in each of the twelve months. However, owing to shortage of time, meter readings were taken on two days only. Nevertheless, useful indicative load profile data have been gathered.

Complete hourly load data and supporting information could not be obtained from 25 HT industries; and the results of the meter-reading exercise and other data collection efforts through the field survey are presented only for 105 industrial establishments.

Figure 4.1 gives the load profile of HT industries, as obtained from the field survey. The individual load profiles of the industrial units covered in the survey are carefully weighted in order to obtain this overall average load curve. About 80% of the industries surveyed have three shifts, 15% have two shifts, and the remainder have one. For about 50% of the industries, the night-shift ends between 7 AM and 8 AM. The dip in the load during this time in the morning may be attributed to the workers in the night-shift switching off their machines and workers in the morning shift switching them on after a certain time interval. The load increases during the next two to three hours as activity picks up and factory offices open.

A slight dip from 12 noon to 1 PM reflects the lunch hour break. And as about 48% of the industries have a shift change between 3 PM and 4 PM, the load dips during this time-interval also. A substantial decline in electricity consumption at about 6 PM is due largely to the fact that single-shift industries close down, and two-and three-shift industries have a tea-break. Finally, the load falls rapidly after 10 PM as the two-shift industries begin to close down, the over-time work in single-shift industrial units comes to an end, and the night shift in three-shift industries begins.

4.3 Preliminary Assessment of Load Management Possibilities

The survey at this stage was also designed to identify, with a reasonable degree of assurance, potential candidate industries for affecting load management. Information on this type of equipment installed, the number of equipment units typically in use in each shift, number of processing steps for the items manufactured, total connected load and maximum kVA demand was also sought. Of the 105 industrial establishments for which this type of information was available, 54 were continuous process industries, and the remainder were essentially batch-process type.

All the 54 HT industries having continuous process activities indicated that high load equipment is in continuous use during normal working hours. This indicates that there may not be significant scope for affecting a load shift from peak to off-peak hours, either with or without tariff incentives*. However, some load shift from day to night time -- or at least a reduction in day time loads -- may be possible in certain continuous process industries. For instance, in cold storage units, during eight to ten hours during the day, only air/gas blowers may be used instead of the entire refrigeration unit.

Of the 51 HT establishments having non-continuous processes, information on equipment installed and its usage pattern was obtained to varying degree of detail, only from 30. The other industrial units apparently had no records of the number and kVA ratings of motors and other electrical equipment installed, or/and kept no records of equipment usage pattern in various shifts.

---

* Of course, overall energy and electricity conservation is possible in these establishments.

Table 4.1 summarizes the findings of the survey of these 30 consumers. Of the 30 HT industrial establishments, more than half belong to the broad category of "engineering industry", which manufacture a variety of items like bearings, rings, pistons, fasteners, fittings, wires, ropes, valves etc. The other industrial establishments manufacture textiles, synthetics, pharmaceuticals, electrical and electronic equipment and so forth. Table 4.1 also gives the equipment usage patterns for selected continuous process industries for which data are available.

The survey shows that the 30 establishments which have non-continuous manufacturing processes (in batch mode), fall broadly into three classes :

(i) Two- or three-shift industries, which use their electrical equipment relatively more intensively (and hence draw a larger load) during one or both of the day-time shifts, i.e. either the early morning to afternoon shift, or/and the afternoon to late evening shift. Those industrial units which have two shifts can make an attempt to use their equipment preferentially during off-peak hours of the day; those which are three shift industries may also do the same, in addition to trying to shift part of their loads to night time. To the extent the loads need to be shifted from peak to day-time off-peak hours, it will be necessary that : (a) adequate in-process inventories be there so that it is possible to accelerate work during off-peak periods; (b) equipment availability is enhanced during day-time off-peak hours; and (c) if necessary, additional equipment is installed. Industrial establishments represented by serial numbers 1 through 4 in Table 4.1 belong to this class.

(ii) Single-shift industries, which use their equipment evenly throughout the working hours. These establishments may consider either adding some equipment or/and reducing the downtime of their equipment and having adequate in - process inventories, for reasons explained in (i) above; or increasing the working hours to work in two shifts. This applies to establishments represented by serial numbers 5 through 11 in Table 4.1.

(iii) Two- or three-shift industries, where the equipment seems to be utilized fairly equally in all shifts. If this information gathered from the field survey is indeed correct, then there is at the very least, a possibility of reducing loads during morning and evening peak hours. This holds true for industrial establishments represented by serial numbers 12 through 30 in Table 5. Those which have three shifts may also consider increasing work during night time. This also may be achieved in a manner similar to that explained in (i) above.

In addition, Table 4.1 includes some information on equipment usage patterns in six other industrial establishments which are essentially of the continuous process type (serial numbers 31 through 36). It is clear that there is not much scope for affecting a load-shift in these industrial units, but it may still be worthwhile to explore the extent to which the batch-mode parts of the manufacturing processes can be rescheduled.

4.4 Detailed Assessment of Load Management Possibilities

The 36 HT industrial establishments for which data are given in Table 4.1, were approached for a detailed assessment of load management possibilities. However, significant progress was made only on 26 of these establishments. Annexure IV.1 lists the name of these establishments and also gives a code for each establishment -- which is used further for referencing the particular units.

As mentioned in section 1.2, a detailed assessment is made for the possibilities of shifting loads from peak to off-peak periods (including incentives required and constraints, if any) and for improving overall efficiency of electricity use.

4.4.1 Share of Energy Consumption in Peak Hours

Individual load curves for the 26 industrial establishments of interest are presented in Annexure IV.2. It may be noted that these load curves are part of the data-base used earlier to derive the overall load curve for the entire HT industry sector consumers.

On the basis of these 26 load curves, the share of electricity use during times of system peak in the morning (9 AM to 11 AM) and evening (7 PM to 9 PM) are presented in Table 4.2.

It is interesting to note that the six hours per day that are designated as system peak hours comprise only 25% of the time. Therefore, in a three-shift industry, it may be considered straight away that if the electricity consumption during these six system peak hours is higher than 25%, there is a clear case for shifting loads to other off-peak hours. Table 4.1 shows that of the 18 three-shift industries under consideration, fourteen consume more than 25% electricity during the designated system peak-hours. Of these, the electricity use of seven exceeds 26% also. However, it is not necessary to limit load management measures only to these industries. For any load shift affected by other industries can also help in smoothening the overall system load curve.

Similar inferences may also be drawn for two-shift and single-shift industries.

However, it must be realized that the load curves are derived from hourly readings taken only on two consecutive working days. Therefore, the influence of several factors on the load curve (like necessity to meet particular production targets on certain specific dates, seasonal variations in production patterns and load profiles) are not considered.

Nevertheless, it is interesting to note that several rounds of discussions with managers and other personnel of the concerned 26 industrial units revealed that eleven would be willing to take (or have already initiated) steps towards shifting part of their loads from peak to off-peak periods. Further, 21 of them also expressed interest in (and were also able to identify particular schemes) for improving overall effeciency of energy use.

4.4.2 Extent of time Shifting of loads

Table 4.4 gives the percentage of load during system peak times, which may be shifted to system off-peak hours for the eleven industrial establishments, whose management was generally aware of the need for shifting loads and also realized the benefits of doing so. In addition, Table 4.4 also identifies the major steps being taken by the management to achieve the load-shifting objectives. These steps fall broadly into two main categories : (i) by changing shift-timings and lunch-hour break timings; and (ii) by rescheduling the operation of certain machines not to operate during certain hours, or by ensuring that certain machines (or effectively, certain portions of connected load) are not operated when certain other machines are in use. Of course, single-shift or two-shift industries also have the advantage of an option for adding a night shift.

The eleven industrial establishments whose managements have evinced some interest in load management do indicate all three kinds of means of shifting loads. Yet, it is important to realize that this may only be the first of a series of measures that can be taken. In particular, after a one/two-shift industry has added a night shift also, and a fraction of the day-time loads have shifted to the night, the management may start thinking of the means to further smoothen their load curve. Likewise, after shift timings or/and lunch hour breaks have been suitably changed (as suggested by MAH2, and already implemented for MAH8 and MAH11), there is still substantial scope.

It is clear therefore, that what is listed in Table 4.4 is a reflection of the management's perceptions (as of now) of load shift possibilities, and obviously underestimates the overall technical (and probably economic) potential for affecting a load shift. In fact, the managers and senior personnel of one or two industrial establishments also clearly stated that they had not given any thought to shifting loads from peak to off-peak periods, even though it was clear that with marginal rescheduling of a few operations, significant load shift is possible (MAH14, MAH15, MAH16 MAH17 and MAH18). However, it is important to note that certain entrepreneurs (of MAH16) do realize the long term benefits that may accrue to them if load management was resorted to by electricity consumers on a significant scale -- better reliability of power supplies which would reduce material losses and damage to machinery.

On the other hand, there are some industrial establishments, whose management needs to be made more "aware" of innovative ideas in production scheduling, production technology etc. The case in point is management of MAH15 who think that the entire operation is of the continuous process type -- while in reality, wire extruding, annealing are continous process operations and drawing, stranding etc. are batch-process-type operations and normally display considerable scope for rescheduling.

4.4.3. Incentives and Constraints for Time-shifting of Loads

Table 4.5 lists the tariff and non-tariff incentives that the industry management requires for shifting loads to off-peak periods. Likewise, Table 4.6 lists the costs that are expected to be incurred for implementing the load shifts, as well as other constraints.

It is evident that the incentives needed and problems/constraints faced extend much beyond the realm of the power sector. And this fact needs to be realized if load management policies are to be implemented on a significant scale.

In fact, one of the entrepreneurs (MAH14) stated in no uncertain terms that they would like to get adequate financial benefits (through tariff and non-tariff means) so that all additional costs of production that they anticipate, are met.

It is interesting to note that HT consumers do feel that the present two-part tariff regime (of a demand charge and an energy charge) does not provide adequate load management incentive. They prefer a penalty clause in the tariff structure (to discourage them from exceeding the contracted maximum demand level) to having demand limiters. Others would want a reduced off peak tariff, and some in particular, have specified that the peak to off-peak tariff ratio may be made very high.

Nevertheless, it is important to note that a reduction in excise and sales tax is desired by many. This certainly means that all costs incurred for implementing a time-shifting of loads need not be compensated through the power-tariff route alone -- a situation that may be more agreeable to the MSEB than if all incremental production costs were to be compensated through a reduction in tariffs alone. However, this raises a series of questions regarding the repercussions that time shifting of loads is to have on the rest of the economy, if even a marginal reduction in excise and other statutory levies are made.

As far as the constraints are concerned, consumers would have to undergo additional expenditure on certain items (Table 4.6). Payment of overtime wage rates, higher in-process inventory levels, provision of transport to the labour force, and other social benefits (better canteen facilities, special benefits to female employees etc.) are generally viewed as the most important costs that may be incurred in affecting a load shift. However, some consumers feel that it is important that trade unions and labour unions should not object to implementing load shifting measures.

Some of the entrepreneurs are even concerned about environmental impacts of expanding their operations on to night time. For instance, MAH5, which is a single-shift industry located in the "chemical zone", is concerned about adding to the pollutant emissions in the Nhava Sheva port area, if they begin working at night also. Clearly, they would prefer that any investment made towards controlling pollution should be compensated for.

4.4.4. Electricity Conservation

Table 4.7 lists the measures for improving electricity use efficiency being adopted/considered in 21 industrial establishments surveyed. It may be noted that power factor improvement, which is now becoming an important issue in India (due to a rise in inductive loads), is being considered by several consumers. In fact, some which have already achieved rather high power factors through adequate reactive compensation, want to pursue this further and achieve power factors of 0.95 or more. However, it is important to realize that reactive compensation per se does not lead to energy use efficiency improvements. It only releases certain "kVA" for sale by utility to other consumers -- this is an advantage to the utility, not the consumer. However, a consumer may also benefit if there is a penalty clause on the demand charge -- for a capacitor will enable the HT industrial consumer to stay below the stipulated maximum kVA demand level relatively more easily. May be it is for this reason that several HT industrial consumers covered in the survey opted for reactive compensation, as given in Table 4.7.

Another important issue being considered widely is the improvement of lighting systems. In addition to replacing conventional incandescent/fluorescent lights by high pressure sodium vapour, mercury vapour or/and halogen lamps, some establishments are also considering better day-lighting by erecting transparent roof tops.

Furthermore, there is a trend towards having better control and instrumentation and better thermal insulation for electrical furnaces. One establishment has also identified the need for improving machine maintenance procedures, and one is considering the use of solar water heating systems for reducing electricity use for heating. A few industrial consumers also claim that they would be converting from electrical heating to oil-based heating. This may lead to conservation of electricity at the consumer's premises, but it essentially entails a substitution of one form of energy by another, and not of conservation.

4.5 Overview

Overall, it would appear that HT industrial consumers are rather interested in taking steps towards implementing various types of load management measures. This obviously indicates that a considerable amount of thought has already gone into such issues -- of course, not all industrial enterpreneurs have a high level of awareness, but the general level seems to be fairly good. Under these circumstances, a suitable package of incentives offered by MSEB could go a long way in achieving the utility's overall load management objectives.

Table 4 1 Maharashtra -- Summary of HT Establishments According to Industry Type

S No	Type\ Category	Product(s)/ Service(s)	No of processing ateps	Contract demand (kVA)	Equipment usage
1	Eng	Bearings	15 to 20	200	Motors 40 installed, 25 in use from 0730 to 1600 hrs; 15 in use from 1600 to 2330 hrs Furnaces 4 installed, 2 in use from 0730 to 1600 hrs. Electrolysis 3 units installed; use as and when required, any time from 2330 to 0630 hrs
2	Eng	Water coolers, split and packaged air-conditioners, heat exchangers, fan coil units, chilled water coils, centrifugal liquid chillers	NA	432	Motors 150 installed, 140 in use from 0630 to 1545 hrs, 100 in use from 1545 to 2330 hrs, 50 in use from 2330 to 0630 hrs Heaters 1 installed, 1 in use from 0630 to 1545 hrs; 1 in use from 1545 hrs to 2330 hrs
3	Eng	Broaches, cutters	NA	600	Motors 168 installed, 140 in use from 0615 to 1445 hrs; 105 in use from 1445 to 2315 hrs, 30 in use from 2315 to 0615 hrs Heaters & Furnaces 677 kVA installed, 600 kVA in use from 0615 to 1445 hrs, 200 kVA in use from 1445 to 2315 hrs, 100 kVA in use from 2315 to 0615 hrs
4	Ele	Current and voltage transformers	12	95	Motors 40 units installed of total capacity of 80 kVA, used evenly round the clock Heaters 6 units of total capacity 100 kVA installed, used evenly round the clock. Furnaces 5 units of total capacity of 125 kVA installed; used evenly in two shifts from 0700 to 1500 hrs and from 1500 to 2300 hrs

S.No	Type\ Category	Product(s)/ Service(s)	No of Processing Steps	Contract Demand (kVA)	Equipment Usage
5	Eln	Industrial electronic equipment, electronic test and measuring instruments, power supplies and inverters	2 or more	196	Total rating of all equipment installed is 271 kVA, used from 0800 to 1600 hrs, single shift industry.
6	Fod	Biscuits	NA	99	Total rating of all equipment is 25 hp, used from 0800 to 1600 hrs, single shift industry
7	Ice	Ice	NA	95	3 motors installed; used from 0700 to 1800 hrs, single shift industry
8	Eng	Pistons, cylinder heads, head rings etc	5 or more	360	Total rating of all equipment is 320 kW, used from 0800 to 1700 hrs, single shift industry
9	Phr	Bilamide, Methural, Ethnorub	2 to 4	142	36 motors of total rating of 123 5 kW installed, used from 1000 to 1800 hrs, single shift industry
10	Eng	Manual arc welding electrodes	3	500	78 motors of total rating of 142 kW and 5 furnaces installed, used from 0700 to 1900 hrs, single shift industry
11	Eng	Copper alloy ingots, C C rods etc	1 to 2	130	5 to 6 motors in use from 0800 to 1700 hrs, single shift industry
12	Eng	NA	NA	75	5 motors with a total rating of 65 kVA installed, used in two shifts from 0600 to 1400 hrs and from 1400 to 2200 hrs
13	Flm	Floor	1	550	112 motors with a total rating of 970hp installed, used in all three shifts (0600 to 1400 hrs, 1400 to 2200 hrs, 2200 to 0600 hrs)
14	Syn	Polyester yarn	3	99	50 motors installed, used in all three shifts (0700 to 1500 hrs, 1500 to 2300 hrs, 2300 to 0700 hrs)

S.No	Type\ Category	Product(s)/ Service(s)	No of Processing Steps	Contract Demand (kVA)	Equipment Usage
15	Tex	Velvet	2	99	69 motors installed, used equally in all three shifts (0700 to 1500 hrs; 1500 to 2300 hrs, 2300 to 0700 hrs) 1 welding machine of 10 hp installed, used as and when required
16	Cem	Refractory motors, refractory castables etc	5 to 6	999	40% of motors installed in use in first shift (0700 to 1500 hrs), 60% in use in second shift (1500 to 2300 hrs)
17	Eng	High tensile fasteners, special fasteners	8 to 10	2410	All motors in use in all three shifts, (0645 to 1515 hrs, 1515 to 2330 hrs, and 2330 to 0645 hrs)
18	Ele	Transformers	6	6170	400 motors of total rating of 7090 kVA installed; electrical heaters of total rating of 1000 kVA installed, all equipment used evenly in all three shifts (0730 to 1530 hrs; 1530 to 2330 hrs, 2330 to 0730 hrs)
19	Eng	NA	NA	160	5 motors of total rating 125 hp installed, used evenly in all three shifts, (0700 to 1500 hrs, 1500 to 2300 hrs and 2300 to 0700 hrs).
20	Eng	Chemical machinery, heat exchangers, pressure vessels, boiler house equipment for sugar plants, structural items	5	750	About 100 motors with a total rating of 1500 hp installed; 50 welding rectifiers installed, all equipment used evenly in two shifts (0700 to 1530 hrs, and 1530 to 2315 hrs).
21	Tex	Shoddy Yarn	5	157	27 motors with a total rating of 208 hp installed; used evenly in all three shifts (0800 to 1600 hrs, 1600 to 2400 hrs; and 2400 to 0800 hrs)
22	Eng	Metal rings, fittings etc	5 to 6	356	All electrical equipment in three shifts, (0700 to 1500 hrs; 1500 to 2300 hrs, and 2300 to 0700 hrs)

S No	Type\ Category	Product(s)/ Service(s)	No of Processing Steps	Contract Demand (kVA)	Equipment Usage
23	Che	Organic peroxides	NA	67	25 motors with a total rating of 66 kVA installed; used evenly in all three shifts (0700 to 1500 hrs, 1500 to 2300 hrs and 2300 to 0700 hrs) 1 welding machine used as and when required
24	Eng	Wires, wire ropes	NA	700	All electrical equipment used evenly in all three shifts (0700 to 1500 hrs, 1500 to 2300 hrs, and 2300 to 0700 hrs)
25	Eng	Beadwire	6	1800	327 motors with a total rating of 2252 kW installed, used evenly in all three shifts (0700 to 1500 hrs, 1500 to 2300 hrs, and 2300 to 0700 hrs)
26	Eng	AAC/ACSR conductors	2	755	260 motors of total rating of 937 kVA, used evenly in all three shifts (0630 to 1445 hrs, 1445 to 2230 hrs, and 2230 to 0630 hrs)
27	Eng	Forgings	5	222	51 motors of total rating 366 hp installed, used evenly in both shifts (0715 to 1515 hrs, and 1515 to 2315 hrs)
28	Eng	Industrial valves	5	59	28 motors of total rating of 107 5 hp installed, used evenly in all three shifts
29	Eng	Dies/jigs/fixtures, tyre cord twisting machines, and high precision fabrication	Varies from job to job*	150	Total rating of all motors is 230 25 hp, used in both shifts (0630 to 1500 hrs, and 1500 to 2330 hrs)
30	Eng	Steel drum closers	8	253	48 motors installed, used evenly in all three shifts (0630 to 1530 hrs, 1530 to 2330 hrs, and 2330 to 0630 hrs)
31	Che	Sul Acid, Al Sul, SSP etc	1 to 4		Motors 472 motors with total rating of 4149 kW installed, used continuously in all three shifts (0815 to 1615 hrs, 1615 to 0015 hrs, and 0015 to 0815 hrs) Heater 1 unit of 26 kW rating installed, used continuously in all three shifts Electrostatic Precipitators 1 unit of 37 kW rating installed, used continuously in all three shifts

S No	Type\ Category	Product(s)/ Service(s)	No of Processing Steps	Contract Demand (kVA)	Equipment Usage
32	Che	Phosphoric Acid, Sodium Tripolyphosphate,	1 to 2	--	Motors. 293 units with total rating of 2229.10 kw installed, used in all shifts (0730 to 1530 hrs, 1530 to 2330 hrs; and 2330 to 0730 hrs) No particular usage pattern can be given
33	Stl	High speed steel, alloy steel, high carbon and chromium steel	5	--	Motors 60 units of total rating of 660 kw installed, 50 used in first shift (0700 to 1500 hrs); 30 used each in other shifts (1500 to 2300 hrs, and 2300 to 0700 hrs)
34	Tex	Wool Tops, Worsted yarn, tc Dyeing	8-10 3-4	--	Motors approx 700 units with total rating of 2134 kVA installed, 80% used in first shift (0730 to 1530 hrs), and 75% used in each of the other shifts (1530 to 2330 hrs, and 2330 to 0770 hrs)
35	Che	Oxygen, Nitrogen, Dissolve Acetylene	1	--	Motors 25 units installed, 25 used in first shift (0700 to 1500 hrs), 22 used in second shift (1500 to 2300 hrs), and 18 used in third shift (2300 to 0700 hrs) Heaters 4 units installed, used evenly in all shifts
36	Eng	Fractional hp motors	10	--	Motors 57 units with total capacity of 325 575 kw installed; used only in two shifts (0630 to 1530 hrs, and 1530 to 2330 hrs) Furnaces Used in all shifts Compressors 2 units installed, used only in first two shifts.

No mass Production

Note		
	Cem	Cement
	Che	Chemical industry
	Ele	Electrical equipment
	Eln	Electronics
	Eng	Engineering
	Flm	Floor mill
	Fod	Food
	Ice	Ice making
	Stl	Steel
	Phr ·	Pharmaceutical
	Syn .	Synthetics
	Tex ·	Textiles

Table 4.2: Maharashtra -- Share of Electricity Use by selected HT Industries During Times Of System Peak (%)

	No. of Shifts	Morning Peak	Evening Peak
MAH1	2	17.4	15.9
MAH2	3	30.4	4.0
MAH3	2	20.4	13.6
MAH4	3	13.0	12.2
MAH5	1	17.1	17.1
MAH6	1	24.6	0.9
MAH7	1	21.3	6.6
MAH8	2	15.2	22.1
MAH9	3	12.4	13.5
MAH10	3	11.8	15.0
MAH11	3	16.6	17.0
MAH12	3	13.0	12.4
MAH13	3	12.3	12.6
MAH14	1	9.6	12.1
MAH15	3	16.4	10.6
MAH16	3	13.0	13.0
MAH17	3	9.7	13.7
MAH18	3	12.8	12.8
MAH19	1	25.2	5.2
MAH20	3	12.5	11.7
MAH21	3	12.3	14.1
MAH22	3	11.3	12.8
MAH23	3	17.0	5.9
MAH24	3	13.0	12.6
MAH25	3	15.7	10.6
MAH26	3	13.4	13.5

Table 4.3: Maharashtra --- Possibility of Load Shifts and Energy Conservation in Selected HT Industries

	Is Load Shifting Envisaged	Is Electricity Conservation Envisaged
MAH1	Yes	Yes
MAH2	Yes	Yes
MAH3	Yes	Yes
MAH4	No	No
MAH5	Yes	Yes
MAH6	Yes	No
MAH7	No	Yes
MAH8	Yes*	No
MAH9	Yes	Yes
MAH10	No	Yes
MAH11	Yes*	Yes
MAH12	No	Yes
MAH13	No	Yes
MAH14	No	Yes
MAH15	No	Yes
MAH16	No	Yes
MAH17	No	Yes
MAH18	No	--
MAH19	Yes	Yes
MAH20	Yes	No
MAH21	No	Yes
MAH22	No	Yes
MAH23	Yes*	Yes
MAH24	No	Yes
MAH25	No	Yes
MAH26	No	Yes

* Partly achieved

Table 4.4: Maharashtra -- Extent of Time Shifting of Loads Possible in Selected Industries

	Manner of Shifting Loads	Connected Load of of machines to be staggered/ operated in off-peak hours	Extent of peak load reduction possible
MAH1	Shift operation of lathes, drilling m/cs, milling m/cs, grinders and bearing splitting m/cs to off-peak periods	245 kVA	About 30%
MAH2	Change shift timings	--	25% to 30%
MAH3	Shift operation of heat treatment facility to off-peak period	677 kVA	40%
MAH5	Possible to add a night shift only if Nhava-Sheva Port work starts in full swing; because then transportation, medical facilities etc. will also become available at night time	--	--
MAH6	By staggering the manufacture and filling/ packing of the produce (an ointment). Also by staggering the operations of mixer and centrifuge	40 kVA	10% to 12%
MAH8	Have already adjusted shift timings and lunch-break timings	--	2% to 5%
MAH9	Most product lines can be shifted to off-peak periods. In particular, heat treatment loads to be increased in the third shift.	300 kVA or more	5% to 10%

contd.../

Table 4.4 contd.

	Manner of Shifting Loads	Connected Load of of machines to be staggered/ operated in off-peak hours	Extent of pea load reduction possible
MAH11	Have already adjusted shift timings and lunch-break timings	--	About 10%
MAH19	Shift heating loads and tool room activity to off-peak periods	70 kVA	20% to 25%
MAH20	Shift operation of plating heaters & presses to off-peak periods	170 kVA	About 30%
MAH23	Have already staggered the operations of electric furnace and rolling mill	1100 kVA	About 50%

Table 4.5. Maharashtra Incentives Required for Time Shifting of Loads

	Tariff Incentives	Installation of Demand Limiters	Other Incentives
MAH1	Reduced off-peak rates, keeping present tariff level as peak rate	No; does not permit flexibility in production processes	(i) Reduction in excise and statutory levies on raw materials (ii) Change from Friday weekly off to Sunday, as at present despatches are disrupted on two days, which calls for a large inventory
MAH2	Maximum demand charges in off - peak periods should be 25% of the present tariff, and off-peak energy rates should be 50% of the present rates	No	*
MAH3	Heavy penalty for exceeding the contract demand level; about 50% reduction in off-peak energy rates	Yes, but the demand limiter should allow for power consumption upto the contract demand level	Exemption of excise duty on various raw materials and other inputs
MAH5	Uniform reduced concessional tariff	No	Heavy Penalty for consumers whose maximum demand does not fall when the uniform reduced concessional tariff is implemented
MAH6	*	*	*
MAH8	*	*	*
MAH9	*	*	*
MAH11	*	*	*
MAH19	Time-differentiated tariffs	No	Reduction in sales, excise and income tax required
MAH20	Time-differentiated tariffs	Yes	*
MAH23	*	Yes	*

* not clearly specified.

Table 4 6 Maharashtra -- Problems Anticipated in Shifting Loads from Peak to Off peak Periods

	Additional Cost with respect to				
	Over time Wage Rates	In-process inventory	Transport	Other items	Other Conditions
MAH1	Yes	Yes	Yes	Supervision, quality control	Should be agreeable to th trade unions
MAH2	Yes	Yes	Yes	Social costs, administrative costs	Should be accepted by the labour union
MAH3	Yes	Yes	Yes	Better canteen facilities	May create labour management problems
MAH5	Yes	--	Yes	Better perks, better canteen facilities	If work at night is to be considered, attention should be paid to the ambient air quality/pollution situation, as the industrial unit is located in the "Chemical zone"
MAH6	-	Yes		-	-
MAH8	-	-	-	-	-
MAH9	Yes	Yes	Yes	Yes	-
MAH11	-	Yes	-	-	-
MAH19	Yes	Yes, about 30%	Yes, 20% to 25%	Better canteen facilities, special benefits to female employees	-
MAH20	-	Yes	Yes	-	-
MAH23	-	Yes	-	-	-

Table 4 7. Maharashtra - Scope for Overall Electricity Conservation

	Measures Adopted/Being Considered			
	Efficient Lighting	Other	Likely Reduction in Energy Requirement	Reactive Compensation
MAH1	Halogen Lamps	Improved machine maintenance; Convert heating loads to furnace oil and LPG	About 50%	Capacitors
MAH2	Yes	-	2% to 3%	Capacitors
MAH3	Halogen Lamps	-	5% to 10%	Capacitors
MAH5	-	-	4% to 5%	Capacitors
MAH 7	-	Timers on motors, temperature control instrumentation on ovens	About 10%	Capacitors
MAH9	Sodium Vapour Lamps	Solar water heaters to partly substitute for electrical heaters	About 10%	-
MAH10	-	Auto-Switch for switching off lights and fans when not required, converting electrical heating to LDO/LPG heating	About 5%	Capacitors
MAH11	Mercury Vapour Lamps	Better day-lighting by having transparent roof	2% to 3%	
MAH12	-	-	2% to 3%	Capacitors
MAH13	-	Converting electrical heating by gas, or/and better thermal insulation for electrical furnace	-	Capacitors

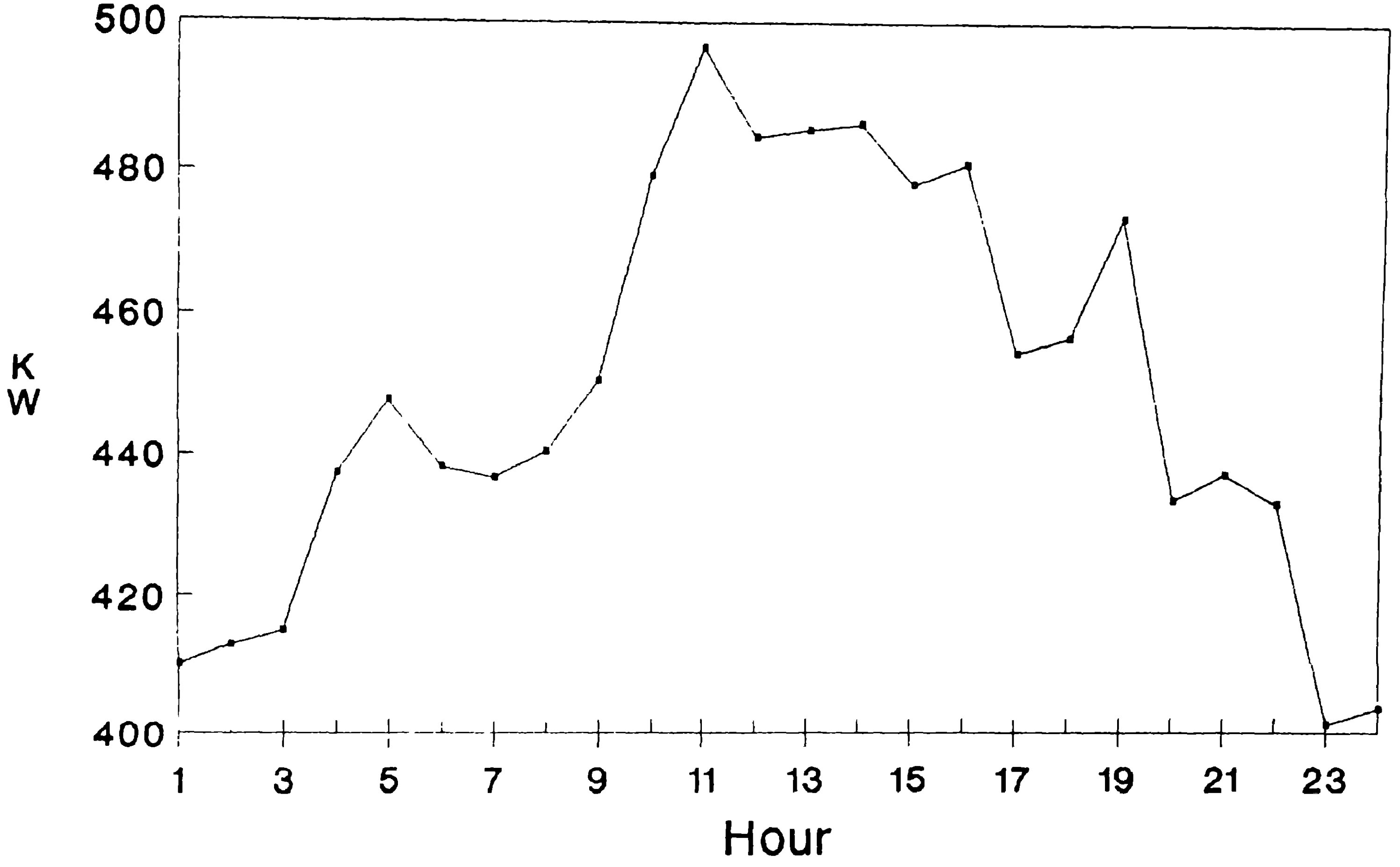
contd .. /

Table 4.7 contd

	Measures Adopted/Being Considered			
	Efficient Lighting	Other	Likely Reduction in Energy Requirement	Reactive Compensation
MAH14	-		2% to 5%	Capacitors
MAH15	-	-	2% to 3%	Capacitors
MAH16	Halogen Lamps, Merc Vapour Lamps	-	About 5%	Capacitors
MAH17	-	-	About 2%	Capacitors
MAH19	Halogen Lamps	-	5% to 10%	Capacitors
MAH21	-	-	-	Capacitors, to achieve a power factor of 0.95
MAH22	HPMV, HPSV Lamps	Use of Electronic Ballasts	About 5%	Capacitors to achieve a power factor 0.96
MAH23			About 5%	Capacitors
MAH24	HPMV, HPSV Lamps	Better day-lighting (transparent roof top); controls for lighting, invest in efficient machines	About 5%	Capacitors, to achieve a power factor of 0.97 to 0.98 (0.95 at present)
MAH25			3% to 4%	Capacitors
MAH26			-	Capacitors

HPMV	high pressure mercury vapour
HPSV	high pressure sodium vapour

Fig. 4.1 MSEB-Average Load Curve for HT-Industries



V. HARYANA -- ASSESSMENT OF LOAD MANAGEMENT POSSIBILITIES IN HT INDUSTRIES

5.1 Introduction

The field survey of HT industrial consumers in Haryana comprised several rounds of discussion with selected HT industrial consumers. Unlike for Maharashtra, where a large sample (of 130 industries) was used to derive the overall load curve for HT industrial consumers in the state, the sample of 27 industries above (Table 3.4, section 3.3) is used to derive what could be considered as a representative load curve for all HT industrial consumers with a connected load of over 500 kW.

Furthermore, where relevant, the findings of the present study are supplemented by conclusions drawn and observations made through another study concluded in 1990*.

5.2 Load Curve

Annexure V.1 lists the HT industrial establishments included in the sample -- and also gives a code for each establishment. This code is used for referencing the establishments in subsequent sections. Hourly meter readings were taken for each of these establishments. Figure 5.1 gives the overall average load curve for the entire HT industrial sector (with connected load exceeding 500 kW). Similarly, figures 5.2. 5.3 and 5.4 give representative average load curves for light engineering, heavy engineering and process industries.

---

* J.L. Bhardwaj,"Flattening of Load Curve and Optimal Utilization of Capacities in the Power System", New Delhi, 1990.

The most notable feature of the load curves depicted in figures 5.1 through 5.4 is that there is a substantial dip in load during the evening hours of 7 PM to 9 PM. This is not a reflection of a genuine decrease in electricity requirements during these hours, but that of power supply restrictions imposed by the HSEB.

There is no noticeable trend of a rise or fall in the power consumption pattern during other hours of the day. This probably reflects the rather dismal situation of power shortages during other times also. Although no power cuts are imposed on industrial consumers during the morning system peak hours and off-peak hours (of the morning, afternoon and night), the voltage and freqauency of power supplies is often rather low, and industrial consumers may prefer to switch over to (partly, at least) their own standby generators to avoid damage to their electrically operated equipment.

It is interesting to note that the overall representative load curve (figure 5.1) shows that the peak electricity consumption is from 1 PM to 2 PM -- an hour that would normally be considered as lunch time and during which, the power consumption would be expected to be low. The same is evident from figures 5.2 through 5.4 also. This perhaps reflects the fact that during this hour, the power consumption of some other types of consumers may be somewhat reduced. This is certainly true for the commercial sector consumers, as brought out from the findings of TERI (1991)*.

---

* TERI,"Estimation of sectoral Contributions to System Load Curves -- Case studies;" for the Project "Policy Directions fo Smoothening the Load Duration Curve in India", New Delhi, March 1991.

Figures 5.2 and 5.4 show that the power consumption pattern for light and process engineering industries is generally similar in terms of pattern and magnitude, whereas that power consumption in heavy engineering industries is much higher in terms of magnitude. Therefore, it may be considered that even among the HT industries, emphasis should be laid on heavy engineering industries for affecting load management.

5.3 Assessment of Load Management Possibilities

Of the 27 HT industrial establishments for which hourly meter readings were taken and discussions held, only six expressed some interest in shifting loads away from the time of the evening system peak.

From the discussions presented below, it becomes evident that the enthusiasm toward affecting load shifts in HT industrial establishments in Haryana is considerably lower than that in Maharashtra. The reasons for this are also explained below.

5.3.1 Extent of Time-Shifting of Loads

The load curves of all industrial establishments in the survey show that the share of electricity drawn from the HSEB grid, during the system peak hours of 6 PM to 10 PM is very low (Table 5.1). It is generally lower than in the hours 6 AM to 10 AM. In those industrial units where this patterns is not observed, the load curve still shows a considerable dip during one to two hours during the 6 PM to 10 PM period.

Therefore, to the extent the HT industrial units prefer to rely on standby/captive diesel generator (dg) sets to meet their power requirements during these hours, it is evident that they would be finding it financially profitable to do so.* Whether implementing a load shift would be similarly profitable or not, is not known; although this is a certain precondition. However, some industrial units have not given any thought to this form of load management -- and those which have, are not usually in a position to assess the benefits. One of the major problems in Haryana therefore, seems to be a general lack of awareness on the possibilities or benefits/costs associated with implementing a load shift.

Nevertheless, it is important to note that six industrial establishments did express an interest in implementing load management measures. Of these, five (HAR5, HAR6, HAR13, HAR16, AND HAR19) expressed interest, at least in part, because the survey was conducted largely during September through November 1990, at a time when there were perceived or real threats of shortages of high-speed-diesel (HSD). Only for one industrial unit (HAR20; Escorts Ltd, Motorcycle and Scooters Division), were any firm estimates of quantum of likely achievable load shifts available. They indicated that approximately 25% of load during peak hours can be shifted to before 6 PM or after 10 PM -- and this shift would entail a lot of rescheduling and streamlining of their operations.

---

* In fact, certain industrial units, (like HAR6, HAR7 etc.) have during certain times, operated for days and even weeks together on their standby generators.

These findings seem to conform to those of another study (referred to in section 5.1), in which it is found that most industrial establishments claim to have little possibility of affecting load shifts, while similar industries in developed countries have made substantial headway in affecting load management through shifting loads. To say the least, there seems to be a lack of understanding, and perhaps, technology gaps as well. This inference is reinforced when one considers that the Punjab-Haryana-Delhi Chambers of Commerce (PHDCC) is of the view that there is significant scope for HT industries to reorganise their operations and shift part of their load to off-peak hours.

5.3.2 Constraints Towards Time-Shifting of Loads

Perhaps the Faridabad Industries Association (FIA) has a good overall perspective, for they feel that there is good potential for shifting loads to night hours (particularly in case of large industries) which are already running three shifts -- if suitable tariff incentives are given and better quality of supply is ensured.

Most of the industries, whether light or heavy, normally have a lightly loaded night shift, when apart from certain essential production activities, equipment repair and maintainence activities are mostly carried out. However, several industrial consumers feel it is rather difficult to intensify operations during night hours, and for the following reasons:

(i) there are a large number of women workers;
(ii) the need to provide transport to workers; and
(iii) the necessity of giving a special night shift allowance (as per Government regulations) to the labour force.

It is generally observed that the usage of electrical equipment in HT industries in Haryana is not evenly spread in the three shifts (unlike that for several industrial units in Maharashtra). The general feedback from the industrial entrepreneurs is that if there is indeed a need to increase productivity in the night shift also (perhaps due to an increase in demand of the items manufactured), this may be done only by incurring additional expenditure towards;

(i) management and control of productivity during the night shift;
(ii) expanding storage facilities to cater to a three shift production process; and
(iii) increasing despatch activities.

All through, it was generally evident that the entrepreneurs have little interest in increasing production (and hence electricity use) during the night shift, just to achieve a load shift. This is largely a reflection of the fact that the consumers do not think that the HSEB can guarantee them adequate power supplies (with voltage and frequency within the stipulated tolerance levels) even during night time.*

In fact, even those industrial establishments which have expressed interest in shifting loads, have done so by attaching certain preconditions, which are:

---

* At present, even during periods of power availability, the quality of power supply is poor, both in terms of voltage and frequency. This has an adverse affect on the performance of the equipment, and shortens the life of individual electrically operated equipment and the plant as a whole.

(i) suitable tariff incentive (either a tariff reduction during off-peak periods by as much as 40%; or a suitable time-differential rate which would lead to adequate savings so as to recover costs of additional investments within a year or two);

(ii) continuous availability of power of desired quality; and

(iii) some sort of financial liability to be imposed on the HSEB towards supplying power of desired quality at least during peak times.

In addition, certain consumers gave other specific reasons in support of their inability to shift loads. For instance, HAR23 (Super Fibres Ltd.),** where one of the operations is pressing an rolling of raw jute fibres, finds that the jute fibres frequently jam the machines. This halts all further operations. As a result, the peak power consumption in the industrial unit depends on when this machine gets jammed and the time taken to rectify the problem. The industrial unit is not in a position to invest in modern machines in which jamming would be less frequent -- and as clearly stated by the management, this investment would in any event not be made with the purpose of shifting loads.

Another industrial unit (HAR25 -- Hitkari Potteries Ltd.) are of the view that as their peak load (which is not necessarily coincident with the morning or evening system peak) is only 25% more than the normal load, they see little reason in affecting load shifts. Further, as most manufacturing work is done by women, they would prefer not to take any steps towards changing the present power consumption profile.

** Manufactures jute twine from jute.

5.4 HSEBs Views on Load Management

Owing to the fact that industrial consumers have expressed in no uncertain terms that the HSEB be made financially liable for supplying power of the desired quality (during peak hours at least), the views of the HSEB were sought.

The general feeling in HSEB, as gauged during discussions, is that it may not be possible to encourage HT consumers to shift loads to "off-peak" hours. This is because in addition to a peak power shortage, there is an energy shortage situation also.*

A major factor which drastically reduces HSEB control on their power system is the fact that a lot of power is drawn from Bhakra Nangal, and it is not infrequent that the state's power supplies get cut without adequate notice. Such power import restrictions make the control over voltage and frequency extremely difficult, and these power deficits get passed down to the final consumers.

HSEB therefore encourages most consumers to augment their power requirement by use of dg sets at their premises.

It was also pointed out by HSEB that a fair amount of syste capacity could be released if the transmission and distribution losses could be reduced from the present level of about 25%. Further, HSEB was of the view that they would be in a better position to ensure a better quality of supply to their consumers once they start drawing power from NTPCs Rihand power station. However, the first of these 500 MW units is expected to come on-stream in 1993/94 and the second in 1994/95 -- by which time the power requirements of Haryana will also have increased further.

---

* About 60% of the consumers in Haryana are in the agricutural sector; and 70% of them are supplied power on an unmetered basis. Only during the monsoon --and particularly when there is a good downpour -- are HSEB left with surplus power.

It was also pointed out by HSEB that it is not possible to undertake a financial guarantee with regard to availability of quality power because of their dependence on power imports from the Bhakra-Beas projects.

In conclusion, it may be said that HSEB presently is not in a position to guarantee supply of power to their consumers; and there is very little they can do to change the situation in the short term.

Table 5.1: Haryana -- Share of Power Consumption in Morning and Evening Peak Hours.

	No. of Shifts	% Power Consumption in Morning Peak Hours (6 to 10 AM)	Evening Peak hours (6 to 10 PM)
HAR1	3	18.6	10.5
HAR2	3	19.8	5.5
HAR3	3	14.9	16.2
HAR4	3	22.9	3.6
HAR5	3	13.9	18.7
HAR6	3	17.6	6.5
HAR7	3	6.1	12.6
HAR8	3	8.3	16.9
HAR9	3	13.8	16.9
HAR10	3	15.1	16.9
HAR11	3	17.2	4.8
HAR12	3	22.8	5.7
HAR13	3	28.1	13.1
HAR14	3	31.5	5.8
HAR15	3	23.5	3.1
HAR16	3	22.0	10.5
HAR17	2*	26.6	3.8
HAR18	3	15.8	8.0
HAR19	3	18.4	8.9
HAR20	3	18.1	17.1
HAR21	3	11.5	21.0
HAR22	3	21.4	16.2
HAR23	2*	20.1	6.5
HAR24	3	14.1	10.9
HAR25	3	17.7	12.8
HAR26	3	17.7	7.8
HAR27	3	18.3	8.2

* of 10 hours each.

Fig 5.1.HSEB-Overall Average Load Curve for HT Industries

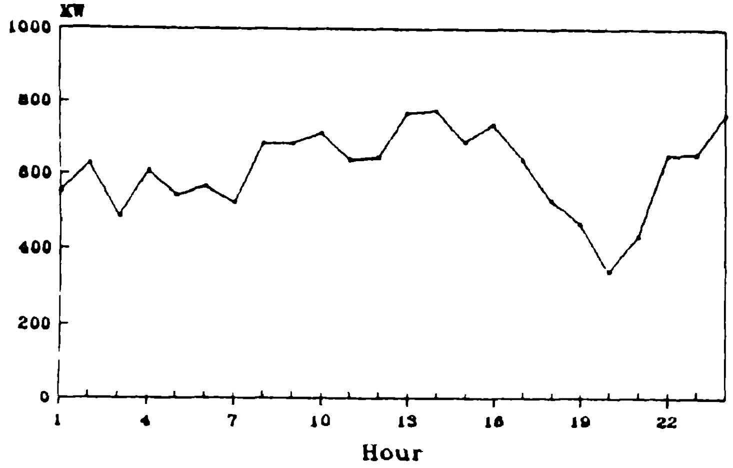


Fig 5.2.HSEB-Average Load Curve for Light Engineering Industries

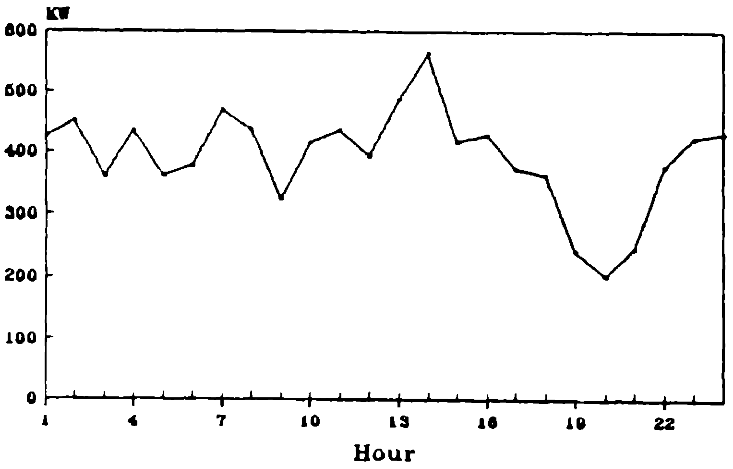


Fig 5.3.HSEB- Average Load Curve for Heavy Engineering Industries

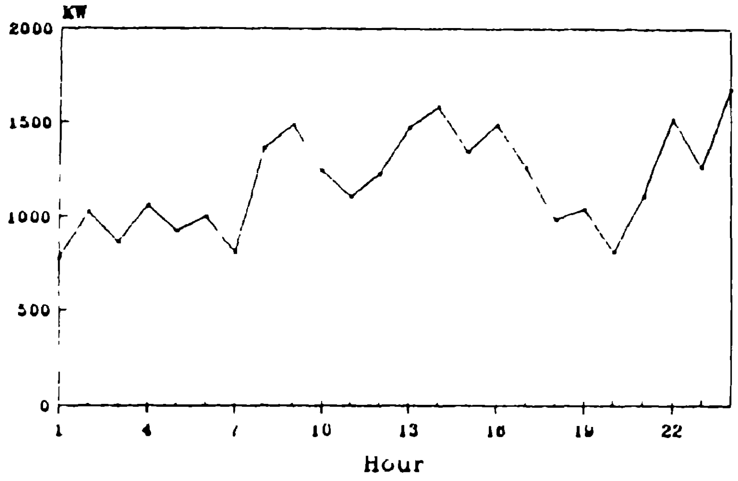
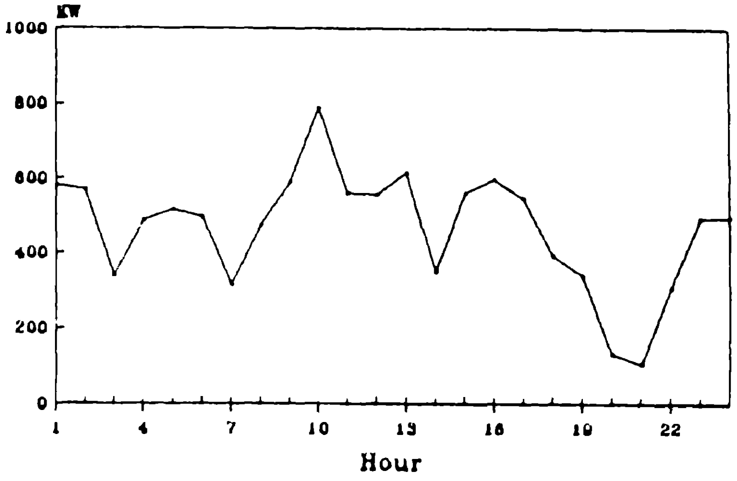


Fig 5.4.HSEB -Average Load Curve for Process Industries



VI. WEST BENGAL -- ASSESSMENT OF LOAD MANAGEMENT POSSIBILITIES IN HT INDUSTRIES

6.1 Introduction

The field survey of HT industrial consumers in West Bengal proceeded in a manner very similar to that in Haryana. Of the 52 industrial establishments selected in the sample, a reasonable response was obtained only from 31 consumers. The responses are discussed below.

6.2 Load Curve

Hourly meter reading were taken on two consecutive working days to obtain the daily load profile. Although this was attempted from all 52 industries, meter readings could be taken only in 24 establishments. Several industrial units that were visited were found closed (these are not included in the list of 31); others were such that the meter room was locked by WBSEB staff, and it was therefore not possible to access the meters.

Figure 6.1 shows the representative load profile for large HT industrial consumers in West Bengal. The load curve shows a dip at 6 AM, as that is the time when the morning shift begins in most of the 23 industries for which meter readings were available. The next dip, from 12 noon to 2 PM probably reflects a slow down in the work pace around and during the lunch hour, and also the end of the first shift. The load rises during evening hours until about 4 PM to 5 PM, when power supply restrictions from WBSEB come into effect. And by 9 PM, the shift changes again when the load also reduces.

It is important to note that this load curve (fig. 6.1) largely represents big, capital intensive, high turnover HT industries only -- for the sample is drawn from the Hoogly-Howrah-Calcutta-24 Parganas belt where large industries are concentrated. The average load of these sample establishments touches 1440 kW (figure 6.1). The representative average load profiles of HT industrial consumers in Maharashtra and Haryana show that the load does not exceed 497 kW and 777 kW respectively. This is so because HT industrial consumers of all contract demand range categories were included in the survey in Maharashtra, while industrial units with a connected load of 500 kW or more only were included in the Haryana survey. On the other hand, the average connected load per HT consumer in West Bengal is the least among the three states (491 kW, compared to 721 kW in Maharashtra and 645 kW in Haryana).

Notwithstanding this, the shape of the load curve may still be taken to be representative of all HT industrial consumers in West Bengal. Table 6.1 shows the percentage of power consumption during the designated morning and evening system peak hours of 8 AM to 11 AM and 5 PM to 8 PM respectively.

In a 24 hour day, a total of eight hours (i.e. one-third of the time) are considered as peak hours. Therefore, if any industry consumes more than one-third of the electricity during these peak hours, it may be concluded that it displays a significant potential for load shift.= Table 6.1 shows that this is the case for twelve of the 23 industrial establishments. However, it may be noted that this

---

= In fact, even those establishments where the power consumption is less than one-third during the designated peak hours, may have significant potential for shifting loads further from off-peak periods.

only pertains to power drawn from the grid -- the use of captive generation facilities is also likely to be higher during the peak hours.

6.3 Assessment of Load Management Possibilities

As already highlighted in section 6.2, relatively large HT industries were included in the sample in West Bengal. However, the survey clearly showed that even these industries have not given much thought towards shifting loads or other forms of load management.

In fact, only nine industrial establishments even indicated that they would be interested in implementing some form of load management strategy. The extent to which these nine industrial establishments will be willing to shift loads is indicated in Table 6.2. All the nine units claim that this can be done essentially by rescheduling the operation timings of certain machines -- although only four are in a position to even broadly identify the production steps that would be rescheduled. In fact, one of the establishment management clearly stated that they would be willing to consider time-shifting of loads only if the WBSEB offered them a concrete package of suitable incentives. In general, the managements of all the units were of the view that they would require a suitable concessional tariff for off-peak hours -- or equivalently, any form of time-differential tariff structure -- as an incentive to shift loads.

However, it is important to realize that the rather poor response towards load shift in West Bengal is not a reflection of a comfortable grid power availaiblity situation -- but only of a lack of awareness regarding the measures that can be taken to mitigate the impacts of unreliable power supplies. Even though several industrial entrepreneurs realize that their productivity may be better in the night shift because the voltage and frequency of the grid power are better (although the performance of the labour force in general, may not be as good during the night shifts), the most commonly held view is that the best -- and perhaps the only -- way to counter the poor power supply situation is to use standby generating sources. Table 6.3 illustrates how power supply restrictions are imposed on the industrial units in West Bengal. Furthermore, the industrial units may not be satisfied with the power availability situation even in other times, as the voltage and frequency sometime drop suddenly. Most of the units use their standby generators during the evening peak time restriction periods -- as well as when the grid voltage and frequency fluctuate beyond normal tolerance limits.

A most unexpected reason given by one of the industrial establishments for not considering time shifting of loads -- and TOU metering -- as a viable proposition, was that as far back as 1984, a similar idea had come from the WBSEB in response to which a separate energy meter for recording the night load had been installed.[‡] Nothing has happened subsequently except that the industrial unit has been paying the meter rent to the SEB.

An attempt was made to gauge whether industrial units in Wes Bengal require power equally intensively in all three shifts (whic was found to be the case for many industrial units in Maharashtra) o whether they normally keep a lightly loaded night-shift (as is usuall the practice in Haryana). Very few units were able to give an estimate of normal power consumption levels during the three shifts.

[‡] The purpose of installing a second energy meter is discussed in Chapter VII.

However, if one goes by the strength of the labour force working in the three shifts (Table 6.4), it is evident that the night shift is somewhat lightly loaded in some cases -- but there are some industrial units in which the staff strength in all three shifts is the same. This suggests, that at least in the latter types of industrial units, power consumption during the night shift may be as high as during the other two shifts. That this does not actually happen is evident from the fact that several entrepreneurs stated that they find the productivity in the night shift to be rather low. Moreover, none of the other industries was keen to expand operations during night time, even though the voltage and frequency are much better.

On the basis of the field survey, it is evident that there is little scope for reducing the system peak demand by time-shifting of loads in HT industries. In fact, even where the possibilities are there and the management is aware of the benefits it may derive from such a move, it is reluctant to take any measures in this direction, due primarily to two reasons:

(i) problems of labour relations, which may arise if the night shifts are to be manned on a rotating basis -- even if the labour force is given due incentives in the form of special allowances, better and subsidised canteen facilities, free transport etc.; and

(ii) a general lack of faith in the ability of the WBSEB to supply uninterrupted high quality power (i.e. voltage and frequency variations within stipulated tolerance limits) even during night time.[‡]

In fact, one of the simple ways of affecting load shifts is to stagger the shift timings. This is a measure that has apparently not been actively pursued by the WBSEB. As a result, for all types of industries in the five areas of West Bengal where the HT industries were surveyed, the shift timings are 6 AM to 2 PM, 2 PM to 10 PM and 10 PM to 6 AM.

In general, it may also be noted that other than time-shifting of loads, there is also a sizeable potential for implementing direct electricity conservation measures in various types of industries. Among the measures that could be adopted are : (i) improving the power factor through adequate reactive compensation; (ii) rationalization of equipment rating in line with loads; (iii) proper maintainence of all equipment; (iv) the provision of efficient lighting and heating devices; (v) the deployment of renewable energy devices where possible; and (vi) investment in proper instrumentation and control equipment.

[‡] Moreover, it may very well be that consumer response in such a field survey improves if sudden power supply interruptions are minimized through proper and systematic maintenance of the generation, transmission and distribution systems.

Table 6.1: West Bengal -- Share of Electricity Use by Selected HT Industries during Times of System Peak

	No. of Shifts	% share of power consumption during	
		Morning Peak	Evening Peak
WEB1	3	39.2	10.0
WEB2	3	20.2	19.1
WEB3	3	19.2	16.6
WEB4	3	40.8	13.6
WEB5	3	11.8	11.9
WEB6	3	15.4	17.2
WEB7	3	25.4	14.8
WEB8	3	18.1	15.1
WEB9	3	18.5	13.7
WEB10	3	18.2	10.9
WEB11	3	20.0	9.8
WEB12	3	18.6	13.6
WEB13	3	18.4	18.3
WEB14	3	19.0	8.6
WEB19	1	22.8	14.6
WEB20	3	25.5	17.1
WEB25	3	20.8	12.8
WEB26	3	25.3	11.8
WEB27	3	36.2	4.6
WEB28	3	24.7	15.6
WEB29	3	18.9	11.6
WEB30	3	18.0	17.5
WEB31	3	19.5	7.7

Table 6.2: West Bengal -- Extent of Load Shifting Possible in Selected Industries.

	Quantum of Load Shift Possible	How will the load be shifted
WEB1	About 10%	By rescheduling certain operations
WEB3	About 10%	By rescheduling certain operations
WEB4	About 120 kW (4 to 5%)	Preparation of scrap steels and milling operations may done only during the night shift
WEB11	*	By rescheduling certain operations
WEB14	5 to 6%	Shifting grinding and other preparatory operations during the night hours
WEB15	About 500 kW (8 to 10%)	By making certain changes in storage capacity in various stages of the production process, several operations such as grinding and mixing may be done only during night hours
WEB16	*	By rescheduling certain operations
WEB17	*	By rescheduling certain operations
WEB18	*	Willing to consider time shifting of loads only if a concrete package of incentives is offered by the WBSEB

* Not clearly specified.

Table 6.3: West Bengal -- Power Supply Restrictions on Selected Industries

	Type of Restriction
WEB1	10% of contract demand supplied
WEB2	Power for lighting loads only
WEB3	Power for lighting loads only
WEB4	Power for lighting loads only
WEB5	Power for lighting loads only
WEB6	-
WEB7	-
WEB8	-
WEB9	-
WEB10	Power for lighting loads only
WEB11	-
WEB12	4.4 MW only (about 80% cut)
WEB13	3.5 MW only (about 50% cut)
WEB14	600 kW only (about 75% cut)
WEB15	-
WEB16	-
WEB17	-
WEB18	Load reduced by about 50%
WEB19	5% of contract demand only supplied
WEB20	Power for lighting loads only
WEB21	-
WEB22	-
WEB23	-
WEB24	-
WEB25	Power for lighting loads only
WEB26	-
WEB27	-
WEB28	-
WEB29	-
WEB30	-
WEB31	Power for lighting loads only

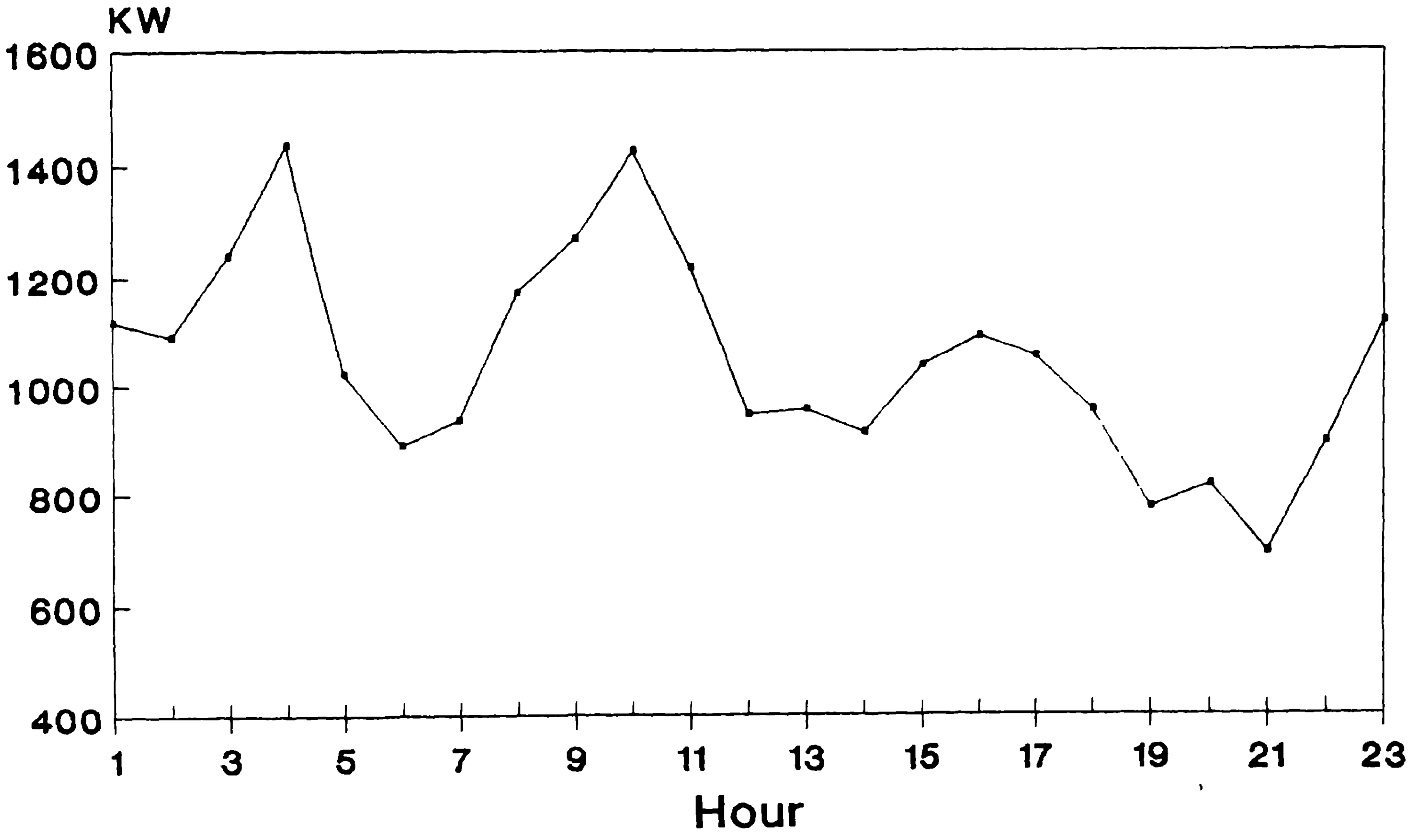
Table 6.4: West Bengal -- Number of Workers in Selected Industries

	Workers employed in		
	First shift	Second shift	Third shift
WEB1	234	217	87
WEB2	5200	3000	1560
WEB3	-	-	-
WEB4	-	-	-
WEB5	25	25	25
WEB6	-	-	-
WEB7	40	40	40
WEB8	300	200	150
WEB9	1200	900	800
WEB10	400	400	400
WEB11	166	164	150
WEB12	2952	1230	1230
WEB13	-	-	-
WEB14	120	120	100
WEB15	500	500	500
WEB16	21	21	21
WEB17	-	-	-
WEB18	80	80	80
WEB19	-	-	-
WEB20	-	-	-
WEB21	-	-	-
WEB22	-	-	-
WEB23	125	125	125
WEB24	1500	1500	1500
WEB25	1060	1060	1060
WEB26	71	68	69
WEB27	-	-	-
WEB28	-	-	-
WEB29	-	-	-
WEB30	625	575	500
WEB31	18	16	16

-: not available

Fig. 6.1

WBSEB -Average Load Curve for
HT-Industries



VII. A SCHEME TO ENCOURAGE LOAD SHIFTS

7.1 Introduction

The discussions in previous chapters have clearly shown that where agreeable by industry, time-of-use (TOU) tariffs and metering provide the best alternative for implementing a load shift.# If consumers are to be subject to TOU tariffs, the power utility would need to make certain investments. These investments are discussed in section 7.3. The consumers may also need to make certain investments (to ensure proper implementation of TOU tariffs*) but these are likely to be small. Section 7.2 details the issues that need to be considered in the tariff formulation process; and a set of TOU tariffs that may be applicable in Maharashtra, Haryana and West Bengal, are presented in section 7.4.

7.2 Basic Issues in TOU Pricing

A view may be taken that the TOU tariffs should be such that overall, the electricty bill paid by industries should be: (i) equal to the bill paid by them to the power utilities under the normal (present) tariff regime, if no load shift occurs; and (ii) less than the present bill paid to the power utilities, if the industries do manage to shift part of their loads to off-peak periods.

Other means, through demand limiters, are in general not acceptable to industry even when they are willing to implement a load shift.

* For instance, for ensuring that the voltage and frequency are within tolerance limits (as desired by HT industrial consumers in Haryana).

However, such a scheme is heavily skewed in favour of industrial consumers, and is not likely to be accepted by any utility. First, because the investment made by utilities is not likely to be recovered by them. And second, because the utilities will most likely suffer a loss of revenue.

Therefore, it becomes important to build-in the investment and related cost components of TOU metering in the TOU tariff structure itself. Some additional investments may also be made by the industrial consumers themselves, but these are likely to be more for purposes of ensuring that the TOU tariffs are properly implemented (particularly, if the industry would like to impose a condition on the utility for supply of power of the desired quality and within the agreed frequency and voltage tolerance limits, as in Haryana). For analytical purposes of deriving a suitable TOU tariff structure, such investments made by the utility need not be considered.*

An estimate of the maximum tariff rate (Rs/kWh) that HT consumers may be willing to pay during peak hours, may be derived from the costs incurred (by the HT consumers) for generating power from standby sources. Most of these standby sources are diesel generator (dg) sets which run on high-speed-diesel (HSD). The dg sets are normally used during times of power supply restrictions (such as in peak hours) and during times of power supply breakdowns, and when the quality of the power supply is poor.

---

* Further investments made by the HT industrial consumers for actually implementing a load shift may also not be considered -- for there is an incentive for this investment which depends on th TOU tariff structure itself (rate ratio between designated peak and off-peak periods).

Cost estimates of power generation from dg sets are given in Table 7.1.[=] Even if the capital costs of dg sets are not considered (which the industry may view as a sunk cost), generation costs using dg sets are rather high (Table 7.2), and may be taken as the upper bound for the tariff rate which an industrial consumer is willing to pay during peak times.

An appropriate peak to off-peak tariff rate ratio may further be taken in order to arrive at a reasonable tariff structure which: (i) provides adequate incentive to the consumer to shift part of its loads to off-peak hours; and (ii) allows the utility to recover its investment within a reasonable time period. The tariff structure for the concerned states are derived in section 7.4, following an assessment of investment required (by the power utilities) in section 7.3.

It may so happen that each particular industrial unit that agrees to a TOU tariff structure, prefers a slightly different rate ratio (3:1, 3.5:1, 4:1 etc.)[==]. In such circumstances, the utility would do well to offer a menu of TOU tariffs to HT industrial

---

[=] These cost estimates are based on a field survey of industrial consumers in Haryana. The field survey was conducted as part of a study by TERI : "Alternative Generation Expansion Strategies for the Northern region", New Delhi 1987. For analytical purposes, i may be assumed that there are no significant differences between Haryana, Maharashtra and West Bengal, regarding annual operation and maintainence expenses of dg sets, salaries/wages of personnel that are hired to run dg sets, HSD price etc.

[==] Ideally, the peak to off-peak rate ratio should reflect the differences in costs of supplying power during peak and off-peak hours. However, as the major objective to TOU tariffs is to encourage load shifts, the rate ratio at which particular industrial units will be impelled to take this initiative, should be kept in mind.

consumers, from which each consumer can choose the option that it finds most suitable.

7.3 Costs of TOU Metering

TOU metering may be implemented in several ways. Of particular interest at present is a simple scheme which suffices for experimentation purposes, and which may also be used on a regular basis for a few years.*

This basically comprises the installation of a second trivector meter (TVM) and two timers (auto reset, independent of voltage and frequency fluctuations) at the premises of selected industrial consumers. A "no-volt" protection feature may also be built in, to prevent the timers from resetting in the event of a power supply failure. The timer contacts are wired into the current circuits of the two TVMs. At any time, one of the two TVMs will be in operation, depending upon the timings selected. Figure 7.1 gives the circuit diagram; the working of the circuit is explained further in Annexure VII.1.

Table 7.3 also gives costs that may be incurred per consumer for implementing the scheme illustrated in figure 7.1. The costs of hardware (one TVM and two timers) are as per latest prices (as of early 1991), and other costs (wiring, labour and erection hardware) may be taken to be indicative -- for they would depend on the actual space available in the meter rooms of the selected industrial establishments. Total costs per each industrial unit are estimated at Rs. 10,700.

---

* It is recognized that before a TOU tariff structure is firmed up, some experimentation -- albeit on a limited scale -- needs to be done in order to gauge the response of industrial consumers regarding time shifting of loads, and the concomittant benefits that may accrue to the utility and the consumers.

If all these costs are to be borne by the power utility and recovered during (say) one year, then the total revenue earned by the utility from that one consumer should be Rs. 10,700 more than what it would be if TOU tariff schemes were not implemented. However, it may be noted that this cost (Rs. 10,700) may form a very small fraction of the revenue earned by the utility from an average HT industrial consumer in one year.

In a more sophisticated but more reliable and expensive scheme, certain add-on-units (AOUs) are installed as front-end devices with the conventional TVMs. For a certain cluster of industries, the AOUs are connected to a data acquisition unit (DAU), which in turn is connected to a central data collection unit (DCU). This DCU, in turn, communicates with a host computer through a modem link. One DCU can handle upto 1000 consumers, within a 600 metres radius. In its simplest configuration, there is no direct link between the ADUs and the DCU, but a meter-reader may use a hand-held unit (HHU) to take the meter-readings at the end of a billing cycle, and feed the data on to a DCU -- which itself may be a micro-computer. This scheme, for a cluster of 30 industrial establishments, is estimated to cost about US$65,000 (Rs 1.65 million) -- or RS 54,200 per consumer. This is only about five times more expensive than the simple experimental scheme described earlier.*

---

* However, its costs per consumer will increase (decrease) as th number of consumers covered by one HHU decreases (increases).

7.4 TOU Tariff Schemes

For analytical purposes of formulating a viable TOU tariff, it may be assumed that:

(i) the costs incurred for captive generation using dg sets give the upper bound for the peak time tariff rate (Table 7.2);

(ii) the ratio of peak to off-peak tariff rate ranges from 3:1 to 5:1, as only such a differential can provide adequate incentive to consumers to shift loads;= and

(iii) The investments towards TOU metering made by the utility should be recovered in a reasonable time period (say one year).**

Other inputs required for computing the TOU tariff menu are:

(i) annual energy consumption per industrial establishment -- which may be derived from the daily load profile given in chapters IV, V and VI for Maharashtra, Haryana and West Bengal respectively; and the number of days per year an industrial unit works (say 300);

(ii) share of energy consumption during designated peak hours -- which is again derived from the above-mentioned load profiles; and

(iii) present average revenue per kWh sold to HT industries in the three states.

= A low rate ratio may not provide adequate incentive for the industry to shift loads, because it may need to make substantial investments before its loads can be shifted from peak to off-peak hours.

** Any operation and maintenance expenses that the utilities may incur to implement these schemes are likely to be small.

For analytical purposes, it is assumed for Maharashtra that the annual grid electricity consumption by an average/typical industrial establishment is 3231.8 MWh, about 25.72% of which is during the designated peak hours of 9 to 11 AM and 7 to 9 PM, and the remainder 74.28% during off-peak hours. Similarly, for Haryana, the average electricity consumption per annum per HT industry may be taken as 4425 MWh*, 30.58% of which is consumed during peak hours, and the remainder 69.42% during off-peak hours. And for West Bengal, the corresponding numbers are 7591.6 MWh, 34.34% and 65.66% respectively.*

On the basis of these assumptions, TOU tariffs are derived, and presented in Table 7.4. It may be noted that the peak rate is much below the cost of generation using dg sets in all states. Secondly, it also interesting to note that even if the utility aims to recover the investment costs of TOU metering (in both the experimental and HHU/DCU schemes) within one year only, the overall tariff rates do not change appreciably. This is essentially because the costs associated with implementing TOU tariffs are rather small in relation to revenues realized from HT industrial units. This supports the view that efforts towards implementing load shifts should concentrate primarily on large consumers -- for a relatively large level of investment per consumer would be justified on economic and financial grounds. TOU rates given in Table 7.4 may be modified further to include a demand charge also for both peak and off-peak periods.

---

* The average annual energy use in Haryana comes out to be higher than in Maharashtra because industrial units with a connected load of 500 kW or more only are considered in the former. The average annual energy use in West Bengal turns out to be still higher as most of the units in the sample have a contract demand exceeding 1 MW -- and that only such units may at first be considered as potential candidates for affecting a load shift in West Bengal.

It may very well be that for a peak to off-peak ratio of 5:1, all the tariff rates given in Table 7.4 are equally acceptable or not-acceptable to consumers in Maharashtra. Likewise, for TOU tariffs with the rate ratio of 3:1 or any other suitable ratio.

Although it may not be worthwhile to implement TOU tariffs even on an experimental basis in Haryana and West Bengal at this stage, the TOU tariff rates for these states are also computed. The TOU tariff rates (even for the same rate ratio) work out to be quite different for the three states because of various reasons, the most important being that the average revenue realized at present from HT industrial consumers per kWh sold is very different: Rs 1.27/kWh in Maharashtra, Rs 1.07/kWh in Haryana and Rs 0.91/kWh in West Bengal. In line with this, the TOU rates are least in West Bengal and most in Maharashtra.

Table 7.1: Baseline Costs of Power Generation using DG sets

a.	fixed operating costs (Rs/kW)	1524
a1	salaries and wages	1159
a2	repair and maintenance	365
b.	Variable Operating Costs (Rs/kWh)	1.2

a. Source: TERI, "Alternative Generation Expansion Strategies for the Northern Region", October 1987; costs in 1985/86 prices converted to 1990/91 prices assuming escalation by 10% per annum in nominal terms.

b. Includes cost of using HSD only (0.3 lit/kWh; Rs 4/litre). Excludes cost of using lubricants, which is normally in the range of Rs 0.05/kWh only.

Table 7.2: Cost per kWh of Power Generation Using DG sets

	Maharashtra	Haryana	West Bengal
a. No of hours of use per year	1000	1700	2000
b. Average load to capacity ratio	0.5	0.5	0.5
c. Annual Gen (kWh/kW)	500	850	1000
d. Fixed annual costs (Rs/kWh)			
- salaries/wages	2.32	1.36	1.16
- repair and maintainence	0.43=	0.43*	0.43=
e. Variable costs (Rs/kWh)	1.2	1.2	1.2
f. Total Costs (Rs/kWh)	3.95	2.99	2.79

a. On the basis of field survey of selected HT industries.

* Source : TERI (1987), op cit ref. Table 7.1

= Assumed to be the same as in Haryana. The wear-and - tear of the dg set per year will be less in Maharashtra and more in West Bengal.

f. Excluding capital costs of dg sets.

Table 7.3: Cost Estimate per HT consumer for Implementing an Experimental TOU Metering Scheme.

Trivector Meter	Rs 4000
Timers (EM 1000)*	2 x Rs 1450 + 2 x Rs 1000
Wiring, Labour and erection hardware (about 20% of the costs indicated above)	Rs 1800
Total	Rs 10,700

---

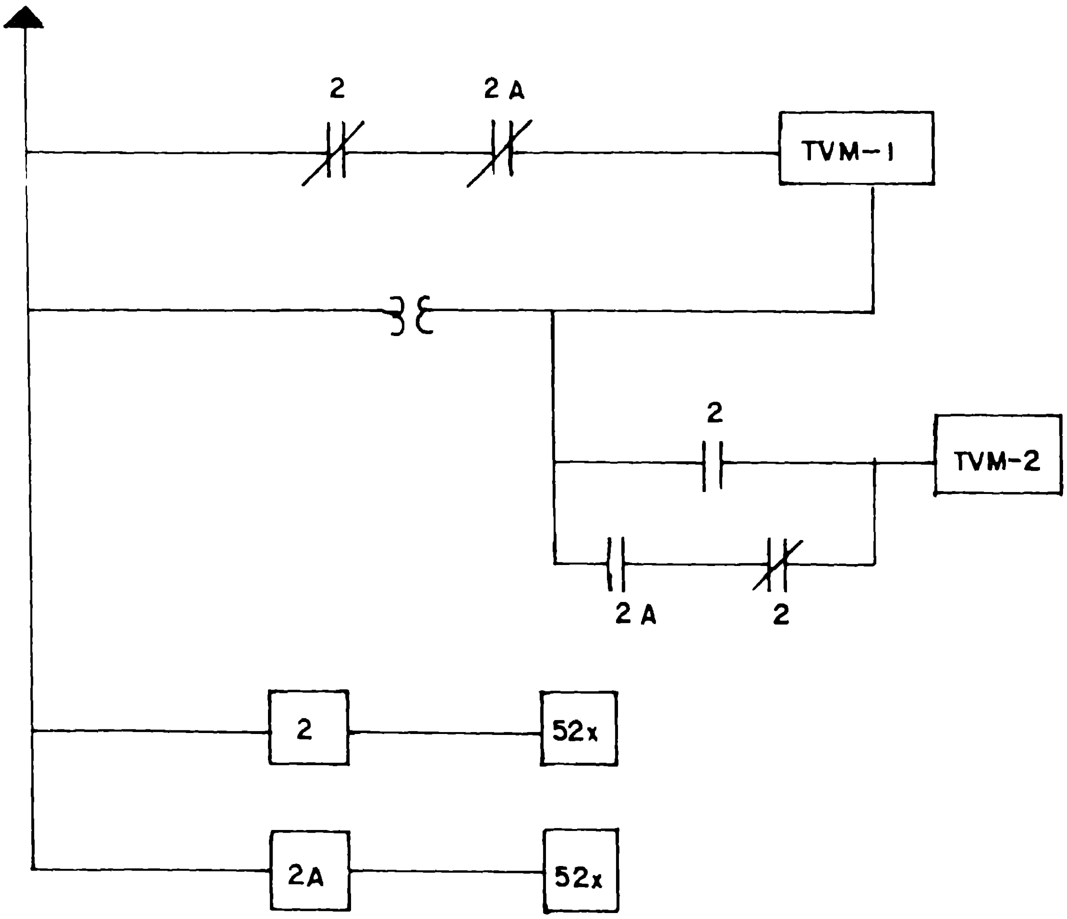
* Of Larson and Tubro make; setting range of 1.5 to 6 hours.

Table 7.4: Suggested TOU Tariff Rates in Maharashtra, Haryana and West Bengal (paise/kWh)

	Maharashtra	Haryana	West Bengal
A. Utility sets up an experimental scheme*			
TOU tariff at 5:1 ratio	313.8 : 62.8	241.2 : 48.2	192.0 : 38.4
TOU tariff at 3:1 ratio	252.3 : 84.1	199.6 : 66.6	162.1 : 54.0
B. Utility Uses HHUs and DCUs*			
TOU tariff at 5:1 ratio	317.5 : 63.5	243.0 : 48.6	193.2 : 38.6
TOU tariff at 3:1 ratio	254.7 : 84.9	201.3 : 67.1	163.1 : 54.4
C. Utility does not recover its investment costs at all			
TOU tariff at 5:1 ratio	313.0 : 62.6	240.6 : 48.1	191.7 : 38.3
TOU tariff at 3:1 ratio	251.6 : 83.9	199.2 : 66.4	161.8 : 53.9

* Utility recovers its investment in one year only.

Figure 71 Design of an Experimental Scheme for TOU Metering



2/2A : TIMER

52x AUXILIARY CONTACTOR FOR CONTACT MULTIPLICATION

VIII. CONCLUSIONS

That there is considerable scope for implementing various load management strategies in HT industries is not in doubt. What is needed is a package of incentives and disincentives to encourage industrial entrepreneurs to take adequate steps towards shifting their loads from times of system peak to off-peak hours -- or to take other measures for improving electricity use efficiency.

Quite often, the problem is that of lack of awareness of the fact that some such load management strategies are possible. In other cases, the managers may be aware, but have not given much thought in this direction -- a fact which reflects precisely the lack of proper incentives.

However, it is interesting to note that this "lack-of-awareness" is not uniform across the country. The survey has clearly shown that in general, even small HT industrial consumers in Maharashtra have a better knowledge or understanding or awareness regarding load management techniques and options, than even large HT industrial consumers in Haryana and West Bengal.

Nevertheless, the provision of tariff incentives (through TOU pricing and metering) is an initiative that would be required in large measure from the utilities. The level of response received as part of this study (both from the HT industrial consumers and the utility) indicates that it is worthwhile to initiate some experimental scheme, at least in Maharashtra. A suitable TOU tariff structure, along the lines given in Chapter VII, may need to be worked out -- or even a menu of tariffs (with peak to off-peak rates varying from, possibly 3:1 to 6:1 and having suitable demand and energy rates for both peak and off-peak periods) may need to be evolved in consultation with individual industrial consumers.

Annexure IV.1: Maharashtra-- Sample of HT Industrial Establishments.

Code	Name of Industrial Unit
MAH1	Gleitlager (I) Ltd.
MAH2	Blue Star Ltd.
MAH3	Dagger Forst Tools Ltd.
MAH4	Indorigin Electric Ltd.
MAH5	Sanghvi Reconditioners Pvt.Ltd.
MAH6	Ethnor Ltd.
MAH7	General Electrodes & Equipments Ltd.
MAH8	Associated Cement Company Ltd.
MAH9	Precision Fasteners Ltd.
MAH10	Crompton Greaves Ltd.
MAH11	Richardson & Cruddas (1972) Ltd.
MAH12	Saravanabara Mills Pvt. Ltd.
MAH13	Bombay Ring Transport Ltd.
MAH14	Plasti Pigments Pvt. Ltd.
MAH15	United Wires Ropes Ltd.
MAH16	National Standard Duncan Ltd.
MAH17	Smita Conductors Ltd.
MAH18	Akson's Mechanical Enterprise.
MAH19	Ferrodie Ltd.
MAH20	Brihan Maharashtra Steel Industries Pvt. Ltd.
MAH21	The Dharamsi Morarji Chemical Company Ltd.
MAH22	Albright, Morarji & Pandit Ltd.
MAH23	Firth (India) Steel Company Ltd.
MAH24	Wellman Hindustan Ltd.
MAH25	Bombay Oxygen Corporation Ltd.
MAH26	Lawkim Ltd.

Annexure V.1: Haryana -- Sample of HT Industrial Establishments.

Code	Type	Name of Industrial Unit	Connected Load Range (kW)
HAR1	LE	Kelvinator Ltd.	>1000
HAR2	LE	Bhartiya Cutler Hammer	>1000
HAR3	LE	Superseals Pvt. Ltd.	>1000
HAR4	LE	Batra Associates.	>1000
HAR5	LE	DLF Universals Ltd.	>1000
HAR6	LE	Delton Cables Ltd.	>1000
HAR7	LE	BCR Ltd.	500-1000
HAR8	LE	Elkay Strips	500-1000
HAR9	LE	Auto Pins Pvt. Ltd.	500-1000
HAR10	LE	Thompson Press	500-1000
HAR11	LE	Oswal Pressure Diecasting	500-1000
HAR12	LE	Asea Brown Boveri Ltd.	500-1000
HAR13	LE	K.G.Khosla Ltd.	500-1000
HAR14	LE	J.V.Electronic	500-1000
HAR15	LE	Khosla Foundries	500-1000
HAR16	LE	Jhalani Tools Pvt. Ltd.	500-1000
HAR17	LE	Gurera Cylinders	500-1000
HAR18	LE	New Allenberry Works	500-1000
HAR19	HE	Oswal Heavy Steels Ltd.	>1000
HAR20	HE	Escorts Ltd. (MSD Division)	>1000
HAR21	HE	Laul's Pvt. Ltd.	>1000
HAR22	HE	Orient Steel Ltd.	500-1000
HAR23	PI	Super Fibres Pvt. Ltd.	>1000
HAR24	PI	Hindustan Vacuum Glass Ltd.	500-1000
HAR25	PI	Hitkari Potteries	500-1000
HAR26	PI	Nuchem Plastics Ltd.	500-1000
HAR27	PI	Pratap Gases and Chemicals Ltd.	500-1000

LE : Light Engineering
HE : Heavy Engineering
PI : Process Industry

Annexure VI.1: West Bengal -- Sample of HT Industrial Establishments

	Name of Industrial Unit	Max. demand in 1989/90 (kVA)
WEB1	Brittania Engg. Products and Services Ltd.	539
WEB2	Hindustan Motors Ltd.	19,850
WEB3	Titagarh Steel Ltd.	4,350
WEB4	Orient Steel and Industries Ltd.	3,444
WEB5	Siddartha Ferro Alloys Ltd.	4,500
WEB6	National Iron and Steel Co. Ltd.	2,950
WEB7	Agarwal Steel Complex	5,307
WEB8	Light Metal Industries Ltd.	2,025
WEB9	Indian Rayon and Industries Ltd.	6,000
WEB10	National Textile Corporation Ltd.	130
WEB11	Kusum Products Ltd.	2,200
WEB12	Dunlop India Ltd.	9,115
WEB13	Tribeni Tissue India ltd.	7,800
WEB14	Hindustan National Glass and Industries Ltd.	2,760
WEB15	Standard Pharmaceuticals Ltd.	4,500
WEB16	Sarbapari Steel Pvt. Ltd.	1,625
WEB17	Dwarkesh Engineering Works	350
WEB18	Vegetable Products Ltd.	908
WEB19	Peico Electronics and Elect. Ltd.	763
WEB20	Texmaco Ltd.	7,000
WEB21	Bhagabati Steel Pvt.Ltd.	429
WEB22	Garden Reach Ship Building and Engineering Ltd.	1,500
WEB23	Shree Engineering Products	527
WEB24	Nuddea Mills Co. Ltd.	240
WEB25	Naihati Jute Mills Ltd.	1,800
WEB26	Somani Ferro-Alloys Ltd.	5,200
WEB27	VXL India Ltd.	917
WEB28	Siemens Ltd.	341
WEB29	The Ganges Mfd. Co. Ltd.	3,936
WEB30	Kesoram Rayon	7,533
WEB31	N.K. Steel Industries Pvt. Ltd.	1,317

Annexure VII.1 : Explanation of Metering Circuit

Ref. Fig 7.1:

BASIS : Assuming two timings for peak hours which may be staggered, say 9 AM to 11 AM and 7 PM to 9 PM.

TVM-1 is for metering during the off-peak hours and TVM-2 is meant for peak hours.

During off-peak hours, none of the timers is energised. Hence, contacts 2 and 2A in the current circuit of TVMs remain closed, and TVM-1 records the power consumption.

At 9 AM, timer 2 energises. At that point of time, NC contact 2 in the current circuit of TVM-1 changes state and TVM-1 stops. Similarly, contact 2 for TVM-2 also changes state, and TVM-2 begins to record the power consumption. Timer 2 remains energised till 11 AM, at which point of time, it de-energises and TVM-1 begins to record the power consumption.

At 7 PM, timer 2A energises, NC contact 2A in the current circuit of TVM-1 changes state.

NC contact of 2A in the current circuit of 2A closes & since NC contact of 2 remains closed, TVM-2 begins to record the power consumption. At 9 PM, 2A again de-energises and TVM-1 begins to record with TVM-2 having stopped recording.

52X are auxiliary contactors meant for contact multiplication of 2 and 2A.